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THE ESSENTIALS OF A GOOD CENSUS*

By Joseph A. Hill, *Bureau of the Census, Washington, D. C.*

A meeting of the American Statistical Association held on the eve of the taking of the Fourteenth Decennial Census of the United States seems to offer a peculiarly appropriate time and occasion for considering the subject of this paper. For the coming census will furnish the foundation for a large part of our statistical work for the next ten years; and if there is one hope that we as statisticians cherish more than any other, it is that we may obtain a good census. To forestall a possible misunderstanding, it may be well to say at the outset that the question which I am going to consider in this connection is not primarily what must be done in order to obtain such a census, but rather what are those features or characteristics which a census must possess before we can pronounce it good. To this question the most probable answer, I imagine, would be that a good census is one which is accurate and complete; and no one certainly will deny that accuracy is a primary essential. But it is not all that is needed to make a good census.

It might be said that accuracy in a census is something like honesty in a confidential employee. No other qualities, however excellent, will compensate for the lack of it, but while essential it is hardly sufficient. Regarding the importance of accuracy, there is in fact no room for differences of opinion. The only question in this connection that might be open to discussion, but one which I shall not stop to consider, is just how accurate a census must be to fulfil the requirements of a good census; for we all recognize that absolute accuracy in a census is neither possible nor, fortunately, necessary, a certain margin of error being permissible as well as inevitable even in the best of censuses.

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* Presidential Address at the Eighty-first Annual Meeting of the American Statistical Association, Chicago, Ill., December, 1919.

Taking accuracy for granted, however, what are the other features of a good census? The taxpayer might suggest economy; and it is unquestionably of great importance that a census be economically conducted even though waste or extravagance may not impair the value of the finished product. One may well be disposed to view the increasing cost of the census with some dismay. The First Census, that of 1790, was little more than a count of population—a very rudimentary census, we should now consider it, which cost the modest sum of $45,000. The census of 1850, which may be regarded as the first comprehensive census, covering in detail population, agriculture, and manufactures, as well as some other subjects, cost $1,400,000. The estimated cost of the Twelfth Census, taken 50 years later, in 1900, was nine times that amount, or $12,500,000.* The Thirteenth Census cost approximately $16,000,000. Of course some part of this great increase in the cost of census-taking was a natural and inevitable result of the growth of the country in population and resources. But that it was mainly due to the expansion of the census as regards the number of subjects covered and the greater elaborateness of the tabulation is evidenced by the fact that the per capita cost, as well as the aggregate cost, has greatly increased. The primitive census of 1790 could have been paid for by a contribution of one cent from every person enumerated. By 1850 the per capita cost had increased to 6 cents. It showed no appreciable advance in 1860, but reached 8½ cents in 1870, 11½ in 1880, and 18 in 1890. That was the maximum. But the reduction to 16 cents at the next census, that of 1900, is fully accounted for by the fact that the decennial census had been relieved of a number of statistical inquiries which previously had been attached to it, but were now either dropped altogether, as was the case with the mortgage investigation, or deferred until the main census was completed. So as a result of this readjustment certain inquiries which were formerly chargeable

* *Report of the Director of the Census*, 1907–8, p. 31.

to the decennial census are now charged to the permanent or intercensal work of the Census Bureau. This readjustment having been effected, the cost of the census resumed its upward course, the per capita in 1910 being 17 cents, as compared with 16 in 1900; and beyond a doubt the census now being taken will cost much more than the census of 1910 for those reasons which make the costs of any enterprise or undertaking and also the costs of living so much greater at the present time than ten years ago.

The great increase in the cost of the census is easily paralleled by the increase in the cost of other governmental functions or activities; and it may be of interest to inquire whether the expenditure for the census expressed as a fraction of the total disbursements of the federal government is any larger now than it was formerly. As the census is taken only once in ten years, the comparison may appropriately be based on the total governmental disbursements for the ten-year period beginning with and including the census year. On this basis the census of 1850 represented a cost of about $248 per $100,000 paid out by the federal government during the ten fiscal years 1850 to 1859, inclusive. The corresponding figure for the census of 1880 was $222 per $100,000; that for the census of 1890 was $298; and that for the census of 1900, $229. Before computing the ratio for 1910, we must take into consideration the fact that the government disbursements during the decade which began with that year and is now just completed include the enormous extraordinary expenditures for the war. For the purpose of a fair comparison I have, however, taken the disbursements for the first five years of the decade, or the years 1910 to 1914 inclusive, doubled this total, and accepted the result as indicating roughly what the expenditures of the government would have been under normal conditions. Comparison of this figure with the cost of the 1910 census gives a ratio of $239 per $100,000. The figures here presented indicate that the cost of the census has at any rate not mounted more rapidly than the general expenses of the government; and I venture the prediction that the cost of the 1920 census, whatever it may be, will represent a diminishing fraction of the total governmental disbursements. Before leaving this phase of my subject, I may give myself the satisfaction of pointing out that these computations mean that out of every $100 paid out by the national government in the course of ten years, about 25 cents is set apart and expended for the census.

These figures are of interest in aiding one to view the cost of the census in its proper perspective. But, of course, they prove nothing regarding the question of whether the cost is justified. An expenditure of $20,000,000 (and the current census will cost more than that) is no trifling sum, no matter how small a fraction it may be of the total expenses of the government, or how small a quotient may result when we use as a divisor the total population of the United States. I take it for granted, however, that the census of the United States is worth twenty millions provided we cannot get it for less. In other words, the census cannot be said to cost too much unless it can be shown that the cost is more than is necessary and that a census equally comprehensive might be taken for less money.

To what limit the cost might mount before reaching the point where we should feel obliged to forego the census or reduce it to a mere count of population required by the Constitution or otherwise materially curtail it, it would be idle to inquire. We may rest assured, I think, that the American people in general, as well as the statisticians and economists, will insist on perpetuating the census. But that does not make it any less essential that the census should be economically and efficiently conducted; and economy is quite as important from the standpoint of the statistician or the user of statistics as from that of the taxpayer. For the less the census costs the easier it will be to extend and improve the statistical work of the federal government; the easier it will be to obtain, for instance, authorization and an appropriation for a quinquennial census of population and agriculture, or an annual census of production, or an adequate compilation of statistics of crime, not to mention other statistical inquiries not yet authorized but greatly needed. In general, the improvement and extension of statistical investigation are conditioned upon economy and efficiency in the organization and conduct of the work of gathering and compiling the basic statistical data.

The introduction of electrical machinery has, as is well known, effected a very great economy in the tabulation of census data. This, however, has been manifested not in any reduction of expenditure, but in a greater output in proportion to expenditure. With the aid of the electrical tabulating machinery we are doing things today that we could not think of attempting if the tabulation had to be carried on by hand, as was the case 60 years ago. Here, as in other fields, the introduction of labor saving machinery has not reduced employment, but has resulted in increased production.

No corresponding advance or improvement has been made in the method or process of collecting the basic data, or in other words, the field work; and the field work in 1910 cost over $7,000,000, representing 45 per cent of the total cost of the census. The compensation of enumerators alone aggregated $4,784,000, which represents about 30 per cent, or nearly one-third, of the total cost. The method of taking the census or of obtaining and recording the basic data is essentially the same as it has been for the last fifty years or more. The enumerator or census-taker makes a house to house canvass of his district, addresses the questions orally to the inhabitants, and enters the answers with pen and ink on a sheet schedule, having one line for each individual enumerated. It is doubtful whether any improvement over this process can be devised which will result in any material economy. The distribution of advance schedules, or lists of questions to be filled out by the inhabitants before the enumerator calls, a procedure which was followed to some extent at the census of 1910, probably insures greater accuracy, but results in no appreciable saving of expense. The use of a punch card by the enumerator has been considered and tried out to a limited extent, but has not yet proved to be a success. The card punched in the field cannot be used for tabulation in the office. For the latter purpose a more perfect card of a smaller size is necessary and the punching must be done with greater precision than is possible in using a hand punch. There are other drawbacks to the use of a punch card from the standpoint of economy, and it is also a question what the effect would be upon the accuracy of the returns. Still it is possible that the punch card may be used by the enumerator at another census.

Economy, however, does not necessarily involve a reduction of expenses. It may be manifested in obtaining a better service at the same cost or even at an increased cost; and with regard to the field work of the United States census the most important problem is not, I believe, that of reducing expenses so much as that of improving the quality of the enumeration, in the direction of greater accuracy, completeness, and reliability. If we are to continue to take the census by the method now followed, the main problem is that of securing a good class of enumerators and placing them under efficient inspection and supervision. One obvious way of obtaining better enumerators is to increase their compensation. The enumerator is employed for about two weeks in the cities and about one month in the rural districts. The average compensation of the enumerators in 1910 was about $70. It will be more than that this time, but the increase probably will not be so great as that which has taken place in the general scale of wages since the last census. To increase the enumerator's pay, however, is seen to be an expensive method of improving the census when we reflect that an addition of $10.00 to the average pay of the enumerator means an increase of almost $1,000,000 in the total cost. Is there any other effective appeal than that to the pocketbook? Can we educate the public to regard the taking of the census as a public service, in which the individual is called upon to assist as a matter of public duty justifying and demanding some degree of sacrifice on his part? We remember in this connection the voluntary and uncompensated services which the citizens of this country cheerfully performed in connection with the draft. Can we successfully appeal to the same motives of patriotism in calling for assistance in taking the census? Probably not. The average American, I think, is decidedly of the opinion that a government which is collecting more than $5,000,000,000 of revenue annually can afford and ought to pay for any peacetime services which it may require from its citizens.

If any material improvements in the field work of the census either in the direction of greater economy or greater accuracy are possible, they must come through better organization and greater efficiency rather than through reduced pay or volunteer services. So far as the present census is concerned, however, the question is purely academic; but it may be well worth thinking about in the course of the next ten years.

Taking accuracy for granted and having achieved economy, what are the other requisites of a good census? One, I should say, is expedition. A census is not a good census unless it is taken and completed promptly. But promptness, like accuracy, is relative or approximate. No census can ever be strictly up-to-date in the sense of representing exactly the conditions existing at the time the census is published. A certain period necessarily elapses between the date to which the census relates and the date of publication, and in that interval conditions change to some extent at least, so that if, as has been said, the census is a snapshot of the population and resources of the United States, we must recognize the fact that some little time is needed for the development of the plate. But the time spent in the dark room should not be unduly or unnecessarily prolonged, nor, I will add, unduly curtailed at the cost of marring the picture by underdevelopment. Opinions may differ as to the period within which a census ought to be completed and published, and the question when a census can be said to be completed is also open to discussion, as there are varying degrees of completeness. But with regard to the census of the United States, the former question has been authoritatively settled by legislation, the law prescribing the period of time within which the census reports shall be completed. It must be assumed that the period is a fair and reasonable one. Therefore, one requisite of a good census in the United States is that it should be completed and published within the period of time prescribed by the law.

The statutory limitation of the period within which the census must be completed was first introduced in the act providing for the Twelfth Census, or the census of 1900. The need of some such limitation was probably suggested and emphasized by the length of time it had taken to get out the reports of the previous censuses. Most of the main reports of the census of 1880 were not issued until near the end of the year 1883, although the population volume and the two-volume compendium appeared in the early months of that year. In the case of the census of 1890, there was even greater delay; none of the main reports was issued much before the close of the year 1894, while the second population volume, containing the occupation statistics, did not appear until 1897.

In this matter of expedition the Twelfth Census, taken in 1900, made a good record; and yet the claim that it practically complied with the new requirement of the law limiting the period within which the reports must be issued is not fully justified. It is true that on July 1, 1902, the date of the termination of the census period, three of the ten main volumes had been published, and six more had been released for printing; these appeared within the next two months, and the remaining volume was published the following October. But the Abstract was not issued until January, 1903, and the Statistical Atlas not until October of that year; the special Occupation Report, which was virtually as much a part of the Twelfth Census reports as any of the numbered volumes, did not appear until June, 1904, practically two years after the termination of the period within which the reports of the Twelfth Census were by law to have been published. In fact, the permanent force of the census office was largely employed in finishing the Twelfth Census work for more than a year after the termination of the census period.*

The Thirteenth Census, judged by any criterion except that of expedition, can, I think, be termed a good census, on the whole the best that was ever produced. But in the matter of expedition it was a sad failure. At the termination of the census period, not one of the main volumes had been issued, and of six series of state bulletins only three had been completed, the publication of the other three having hardly been begun. The first main volume to appear was issued in December, 1912, six months after the termination of the Thirteenth Census period as defined by law. The Abstract appeared in February, 1913, and the other volumes at intervals throughout that year, with the exception of the general report on population, which went over into the next year, appearing on January 5, 1914, and the occupation volume, which was not issued until July, 1914.

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* *Report of the Director of the Census*, 1907–8, p. 30.

But to revert to the other question previously suggested, when can it be said that a census is completed? If not until all the basic data obtained have been duly tabulated and adequately exploited, then it can hardly be said that any census has ever been completed. Indeed every census, at least since that of 1850, has contained questions which have never been tabulated at all. I am referring now to the main census subjects. I am not considering the various secondary investigations which were formerly tied up with the main census and which included numerous interrogatories that never bore any statistical fruit.

The most striking recent instance of the neglect or failure to utilize all the available data obtained through the census is afforded by the question asking the number of children borne by each mother and the number still living at the date of the census,—a question which appeared on the population schedule in 1890, 1900, and 1910, but remained unutilized with the single exception that some of the 1900 data covering a few small selected areas were tabulated by the Immigration Commission and published in its reports.

The question of completeness, as I have said, is one of degree. It is not merely a question of making some use of every class of data on the schedules. It would be possible to tabulate the answers to every question and still have a census which would rightly be considered very deficient. We might, for instance, show ages for the total population only, without any distinction as to sex, color, or nativity; or show occupations without any age or sex distinctions. We might present a given classification for states only and not for cities, or for states and cities but not for counties. The question of completeness is thus a question of elaboration, of cross classification, or correlation, of detail.

The possibilities of detail and of elaboration in tabulating the results of the census are almost infinite. But it must be assumed, I think, that when Congress in the law providing for the Twelfth Census prescribed the period within which the census reports must be completed and published, it had in mind the established standard; or in other words, it had in mind reports having about the same scope and detail as those published in connection with the censuses of 1880 and 1890. The Bureau of the Census at any rate cannot undertake to do more than that within the census period; and it will do well if it does that.

But is it necessary to stop there? Will the census office be debarred from making any further study or use of the Fourteenth Census data by this requirement of the law that the reports upon the inquiries shall be completed and published before July 1, 1922? When that date arrives and the main census reports have happily been completed and published, must the schedules be relegated to the dust of storage to be referred to only when some one for a good and legitimate reason affecting, perhaps, property interests, wants to know whether John Smith of Smithville was a married man in 1920? It is one feature of a good census, surely, that the data obtained by it at such great expense should be fully utilized, exploited, and interpreted, or, in other words, that we get out of the census all that there is in it. Otherwise we fail to realize on our investment.

I obviously am assuming that the data on the original schedules are *not* adequately exploited when the main reports are issued. Experience justifies that assumption. I have already called attention to the fact that at every census certain questions on the schedules have been entirely neglected; but quite aside from this, the need and opportunity for further tabulations have been made evident regarding questions or classes of data which were not entirely neglected, but were covered in a general way by the main reports. For instance, the preparation of the Twelfth Census report on occupations involved a further tabulation of census data after the main reports were completed. This is also true of the special reports on Women at Work and on Child Labor. The Supplementary Analysis does not belong in quite the same class because it was simply a study, analysis, and reclassification of statistics already published in the main reports, and did not involve the utilization of any unpublished data. The statistics used as the basis of this work were, therefore, available to any one who wished to make use of them. Nevertheless, it is safe to say that no private individual, and probably no institution other than the census office, could have undertaken the work involved in the preparation of that volume. It required the equipment of an organized statistical office supported by the resources of the federal Treasury.

Another illustration of the fact that the census data are only partially exploited in the main reports is afforded by the plan which was considered at both the Twelfth and the Thirteenth Census for a tabulation of data relating to the family. In the main census reports, the unit is the individual. No facts are shown regarding the family beyond the mere number of families, classified by size and by the tenure of their homes. In the projected report, all the significant census facts regarding the family, such as the occupation of the head of the family, the number of children—the number at school and the number at work—the presence or absence of boarders or lodgers, were to have been tabulated. At the Twelfth Census cards were actually punched for the family tabulation.*

It is by no means always necessary to go back to the original schedules to find new and interesting information not contained in the main reports of the census. Frequently it is a question simply of another run of the punched cards through the tabulating machines. Suppose, for instance, that it is desirable—as I think it is—that the facts regarding sex, age, marital condition, illiteracy, and ability to speak English should be shown not merely for the foreign born population as a whole, as is done in the main reports of the census, but for each foreign nationality separately, the Germans, the Irish, the Italians, the Swedes, etc. Another run of the cards would furnish this information. It is fairly evident, then, that the data obtained by a decennial census cannot be fully exploited or adequately analyzed and presented within the period of a little over two years allowed by law for the completion of the reports. That, as Director North truthfully said in his first report following the termination of the Twelfth Census period, is physically impossible. Either the data must be abandoned or buried when only partially utilized, or we must continue the tabulation, study, and analysis of the census after the census period has terminated. I can, I think, take for granted that the audience I am addressing would advocate the second of these alternatives; and the census office since it became permanent has, in fact, as I have already pointed out, supplemented the main reports by special reports or studies prepared and published after the termination of the census period. But it has never done all that it has planned to do in this direction, has never, in my opinion, planned to do as much as should be done, and has felt compelled to apologize more or less for doing as much as it has done, the apology being intended to forestall criticism for issuing delayed reports and publishing figures alleged to be out of date. It is highly desirable that the further exploitation of the census data be continued after the termination of the census period as defined by law, and that the public should be brought to appreciate the importance of this work, as it would be, I think, if in accordance with the recommendations of the Census Advisory Committee representing this association, a series of supplementary census studies, wisely planned and carefully prepared, were published soon after the completion of the current census.

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* *Report of the Director of the Census to the Secretary of the Interior*, 1903, p. 5; *cf.* also *Report of the Director to the Secretary of Commerce and Labor*, 1903–4, p. 4.

THE MORTALITY OF RACE STOCKS IN PENNSYLVANIA AND NEW YORK, 1910

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The United States offers an especially good opportunity to the demographer to study the comparative mortality of the principal European race stocks. In this country, a considerable proportion of the population is of foreign origin and the several races live together in close proximity in the large centers on the Eastern seaboard. The presence of these people in ever increasing numbers has undoubtedly had its effect in modifying the demography of the country. A study of the statistics, with due regard to race stocks, should show just what the effect of this immigration has been on the total mortality of the country. It is quite possible that certain disquieting features of the mortality in recent years, such as the increasing death rates after age 45, may be due largely to such immigration. Such study should, furthermore, throw considerable light on a question that is of great interest to the social economist, namely, whether residence in the United States has had any effect, favorable or otherwise, on the mortality of these race stocks since their arrival.

It was with such purposes in mind that one of the writers, several years ago, carried out an investigation* of the mortality of the more important races living in the state of New York. The results showed very clearly that the foreign stock suffered appreciably higher death rates than the native stock, that is, those of native parentage. Among the immigrant peoples, considerable diversity was found. The Russians, who are mostly Jews in New York State, and the Italians, showed remarkably low death rates, while persons of Irish and German birth suffered from very high death rates, and especially from pulmonary tuberculosis and the so-called degenerative diseases.

The results of this investigation were of such interest and significance that it has seemed desirable to amplify the study of the problem by subjecting additional data to a similar analysis. Through the courtesy of the Director of the Census, Hon. Sam L. Rogers, to whom our thanks are due, it has been possible to obtain the necessary basic material for the state of Pennsylvania. This is a large industrial state with a high proportion of foreign stock. The absolute numbers of the foreign born are also large enough to warrant an analysis by the items of country of birth, age and sex. This paper will present the new facts in comparison with those previously published for New York State and will restate the combined results in the light of the additional evidence. We may note at this point that the findings in the two states completely confirm each other and remove all doubt as to the reliability of the earlier study.

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* Dublin, Louis I., "Factors in American Mortality," *American Economic Review*, Vol. VI, No. 3, September, 1916.

The first table presents the structure of the population of Pennsylvania and New York with reference to nativity. Distinction is made between the native born by parentage and the foreign born by country of birth. It is possible to differentiate in the last group the following nationalities: Austro-Hungarians, Russians, Italians, Germans, British, and Irish; these are arranged in a descending order according to their

TABLE I

NUMBER AND PERCENTAGE DISTRIBUTION: (A) OF TOTAL WHITE POPULATION BY NATIVITY, PARENTAGE OF NATIVE BORN, AND COUNTRY OF BIRTH OF FOREIGN BORN; AND (B) OF TOTAL WHITE FOREIGN BORN, BY COUNTRY OF BIRTH. PENNSYLVANIA AND NEW YORK STATE, 1910

Population class	Pennsylvania			New York		
	(A)		(B)	(A)		(B)
Total white population	7,467,713	100.0	....	8,966,845	100.0	....
Native born	6,028,994	80.7	....	6,237,573	69.6	....
Native parentage	4,222,727	56.5	....	3,230,325	36.0	....
Foreign, mixed parentage	1,806,267	24.2	....	3,007,248	33.5	....
Foreign born	1,438,719	19.3	100.0	2,729,272	30.4	100.0
Austria-Hungary	375,271	5.0	26.1	341,836	3.8	12.5
Russia	240,980	3.2	16.7	558,952	6.2	20.5
Italy	196,122	2.6	13.6	472,192	5.3	17.3
Germany	195,185	2.6	13.6	436,874	4.9	16.0
Great Britain	170,356	2.3	11.8	193,359	2.2	7.1
Ireland	165,091	2.2	11.5	367,877	4.1	13.5
Other foreign born	95,714	1.3	6.7	358,182	4.0	13.1

proportionate representation in the population of Pennsylvania at the time of the 1910 census.

It is understood that the several designations of country of origin of the foreign born are not always indicative of race stocks, since a few countries include a number of different races. This is especially true of Austria-Hungary and Russia. As we shall see later, the composition of these groups is also somewhat different in Pennsylvania and New York.

We find in Pennsylvania that these six foreign groups together comprised 18.0 per cent of the total white population in 1910 and 93.3 per cent of all the foreign born; in New York, they constituted 26.4 per cent of the total white population and 86.9 per cent of all the foreign born. In these two states, accordingly, the foreign populations are sufficiently large to justify careful study in comparison with one another and with the native elements of the population.

The first step will be to compare the specific death rates in the states of Pennsylvania and New York of (A) the native born of native parentage, (B) the native born of foreign or mixed parentage, and (C) the foreign born. Table II presents the facts for each sex and by age periods.

An observation should be made before the figures for these three classes of the white population are compared. The foreign born are but lightly represented at the ages 1, 2, and 3 years, at which periods mortality rates are high. Lacking this component, the death rates for the foreign born under age 10 are not comparable with those of the other two groups of the population, which include a normal proportion at these earliest ages. Beginning with age 10, however, the figures for the three groups are comparable for all practical purposes.

The figures for both states are remarkably similar and bear out the following observations. At ages 10 to 19, the death rates are much the same for the three classes, with the single exception of the foreign born males, ages 15–19, in Pennsylvania, whose very high death rate is undoubtedly due to occupational hazards. But, beginning with age 20 and continuing throughout the rest of life, the rates for the native born of native parentage are decidedly the lowest of the three groups, the only exception being among the foreign born females in New

TABLE II

DEATHS PER 1,000 WHITE POPULATION AMONG (A) NATIVE BORN OF NATIVE PARENTAGE, (B) NATIVE BORN OF FOREIGN OR MIXED PARENTAGE, AND (C) FOREIGN BORN, BY SEX AND AGE PERIOD. PENNSYLVANIA AND NEW YORK STATE, 1910*

Sex and age	Pennsylvania			New York		
	(A) *NB, NP*	(B) *NB, FMP*	(C) *FB*	(A) *NB, NP*	(B) *NB, FMP*	(C) *FB*
MALES						
All ages:						
Crude rate	14.2	21.2	16.4	15.9	18.7	17.2
Ages 10 and over:						
Crude rate	11.5	12.6	16.5	13.8	13.2	17.5
Standardized†	12.8	18.8	17.5	13.8	19.5	17.3
Under 10	22.6	38.2	11.5	23.5	31.0	8.4
10–14	2.3	2.6	2.6	2.5	2.2	2.5
15–19	3.3	4.1	6.1	3.6	4.1	4.4
20–24	4.9	6.2	7.3	5.0	6.8	5.2
25–44	6.2	12.3	9.1	6.9	14.3	8.7
45–64	16.8	25.7	25.9	18.8	28.2	28.0
65–84	75.2	91.4	91.5	77.3	89.9	90.4
85 and over	253.0	476.5	279.4	268.9	323.0	272.7
FEMALES						
All ages:						
Crude rate	12.7	17.3	16.7	13.9	14.7	16.3
Ages 10 and over:						
Crude rate	10.9	10.0	16.9	12.4	9.7	16.6
Standardized†	12.3	16.3	16.0	12.4	15.5	16.2
Under 10	18.6	32.6	10.8	19.6	27.0	8.2
10–14	2.3	2.2	2.2	2.6	2.1	2.4
15–19	3.3	3.1	3.7	3.2	3.2	3.2
20–24	4.2	5.4	5.0	4.7	5.2	4.0
25–44	5.8	8.5	7.4	5.7	9.3	7.3
45–64	14.4	18.1	21.4	14.3	20.0	23.4
65–84	66.6	86.0	86.7	68.2	73.9	87.7
85 and over	253.8	445.3	276.6	242.3	324.9	270.5

* Deaths in unspecified parentage and nativity groups distributed *pro rata* among specified nativity and parentage classes.

† Standardized for age distribution on basis of native born of native parentage, each sex, in New York State, 1910.

York, ages 20–24. The advantage of the native stock becomes greater with advancing age. A comparison of the two branches of the foreign stock shows a remarkable similarity in the death rates from age 10 onward. The one striking exception is at the ages 25–44, during which period the foreign born males have very much lower death rates than the native born of foreign parentage. The causes for this difference will be made evident later.

Perhaps the best single measure of the comparative mortality of the three classes is found in the standardized rates for the ages 10 and over. In this rate, the figures under 10, which, as we have seen, are incomparable, are eliminated from consideration. It indicates the mortality which would result for the class in question if its age distribution were the same as that of the native born of native parentage in New York State —the base used for standardizing rates throughout this paper. When thus considered, the superior vitality of the native stock is fully demonstrated as to both sexes; but the superiority of the males is more striking than that of the females. The presence of the foreign stock has, therefore, had the undoubted effect of increasing the total death rate in both these states, especially after age 45 is attained. In Pennsylvania, this fact has increased the crude rate from 13.4 deaths per 1,000 to 15.6; and in New York, from 14.9 to 16.1.

In general, the respective rates for Pennsylvania are lower than those for New York. The only significant exception is in the case of the foreign born males at ages 15 to 44. We shall see later that this results from occupational hazards in mines and mills which are more serious in Pennsylvania than in New York.

We shall now resolve the death rates of the "foreign born," as given in columns (C) of Table II, into the rates for the various nationality groups. This will indicate how the several elements of the foreign born compare with one another, and which ones are responsible for the unfavorable mortality of the group as a whole. Unfortunately, it is at present impossible to compare each foreign born group with the native born group of corresponding parentage, *e. g.*, the Russian born with the native born of Russian parentage. We shall be compelled to consider each foreign born race in comparison with the native born of native parentage.

AUSTRO-HUNGARIANS

We shall consider first the Austro-Hungarians, one of the six groups which together make up the bulk of the foreign born in Pennsylvania and in New York. Immigration to America from Austria-Hungary has become important only since 1890, although in recent years the Austro-Hungarians have been one of the most numerous components of our immigration. In 1910, there were 375,271 Austro-Hungarians in Pennsylvania, constituting 26.1 per cent. of the foreign born whites and 5.0 per cent. of the total white population. They find employment in great numbers in the mills and mines and in other coarse manual labor. In New York State in 1910, this element of the foreign born was not so large proportionately. There were 341,846 Austro-Hungarians in New York, which was 12.5 per cent. of the foreign born whites and 3.8 per cent. of the total white population.

This nationality is, of course, heterogeneous as to race stock, containing large proportions of Jews, Germans, Southern Slavs, and Poles.* In Pennsylvania, persons recorded as born in Austria-Hungary are largely Slovaks, Magyars, and Slovenians, while in New York a large portion of the Austro-Hungarians are Jews. Table III shows the death rates for Austro-Hungarians in Pennsylvania and New York, respectively, distinguished as to sex and age period.

The first two age periods must be disregarded because of the paucity of data. In Pennsylvania, we find that for each sex and at every age period from 15 to 64, the rates for Austro-Hungarians are much higher than for the natives. This same characteristic remains when the rates are standardized for age. In New York State, the rates for the two groups run nearly parallel to each other, with slight fluctuations in the various age periods. When standardized, the Austro-Hungarian rates are virtually the same as those for native stock. We shall see later that these differences in the two states are largely accounted for by the differences in the hazards of occupation.

The death rates for Austro-Hungarians in Pennsylvania and in New York may be compared with figures for corresponding groups in their native country. The facts are available for each of the two main divisions of the former Empire, Austria and Hungary, separately.† On the whole, the rates are higher

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* Deaths of Poles given separately in census returns were distributed among Russians, Austro-Hungarians, and Germans, according to the percentages of all persons of Polish mother tongue in Pennsylvania and New York (census of 1910) who had come from the respective countries.

† *Annuaire International de Statistique:* I. Etat (pp. 55, 57), and II. Mouvement (pp. 80, 92) de la Population (Europe). La Hague, 1916–17.

TABLE III

DEATHS PER 1,000 WHITE POPULATION AMONG PERSONS BORN IN AUSTRIA-HUNGARY AND AMONG NATIVE BORN OF NATIVE PARENTAGE, BY SEX AND BY AGE PERIOD. PENNSYLVANIA AND NEW YORK STATE, 1910

Sex and age period	Pennsylvania		New York	
	Native born of native parentage	Austro-Hungarian born	Native born of native parentage	Austro-Hungarian born
Males				
All ages:				
Crude rate	14.2	9.7	15.9	9.3
Ages 10 and over:				
Crude rate	11.5	9.7	13.8	9.4
Standardized rate	12.8	14.4	13.8	14.3
Under 10	22.6	11.6	23.5	7.4
10–14	2.3	3.0	2.5	2.8
15–19	3.3	5.5	3.6	4.1
20–24	4.9	7.1	5.0	4.3
25–44	6.2	8.5	6.9	6.7
45–64	16.8	22.3	18.8	21.0
65–84	75.2	63.9	77.3	77.5
85 and over	253.0	181.8	268.9	301.6
Females				
All ages:				
Crude rate	12.7	8.0	13.9	7.4
Ages 10 and over:				
Crude rate	10.9	7.7	12.4	7.3
Standardized rate	12.3	13.5	12.4	12.4
Under 10	18.6	12.3	19.6	8.2
10–14	2.3	1.7	2.6	1.6
15–19	3.3	4.0	3.2	2.0
20–24	4.2	5.9	4.7	3.5
25–44	5.8	7.1	5.7	5.8
45–64	14.4	16.7	14.3	18.2
65–84	66.6	75.5	68.2	63.9
85 and over	253.8	114.3	242.3	213.5

in Austria and in Hungary than among their emigrants living in this country. Thus, in the years 1908–13, males aged 25–44 had death rates of 8.8 and 8.9 per 1,000 in Austria and Hungary, respectively, as compared with 8.5 and 6.7 for Austro-Hungarians living in Pennsylvania and in New York; at ages 45–64, the corresponding rates were 24.2 for Austrians, 23.4 for Hungarians, and 22.3 and 21.0 for Austro-Hungarians in Pennsylvania and New York, respectively. The advantage of Austro-Hungarians in America is apparent, in spite of their occupational hazards which often result in death from accident, especially in Pennsylvania. The conditions are very similar for females.

TABLE IV

DEATH RATES OF WHITE PERSONS BORN IN THE UNITED STATES, FOR THE PRINCIPAL CAUSES OF DEATH, BY SEX AND BY AGE PERIOD. PENNSYLVANIA AND NEW YORK STATE, 1910

Sex and age period	All causes		Tuberculosis of lungs		Cancer		Organic heart diseases		Pneumonia		Bright's disease		Violence excl. suicide	
	Rate per 1,000		Rate per 100,000		Rate per 100,000		Rate per 100,000		Rate per 100,000		Rate per 100,000		Rate per 100,000	
	Pa.	N. Y.	Pa.	N. Y.	Pa.	N. Y.	Pa.	N. Y.	Pa.	N. Y.	Pa.	N. Y.	Pa.	N. Y.
MALES														
All ages	16.1	17.1	105.1	170.9	40.3	46.5	114.5	139.1	175.5	203.8	75.4	93.6	113.0	99.2
Under 10 ...	28.4	27.7	23.3	23.4	1.9	3.4	24.5	22.7	412.1	467.6	8.9	8.5	86.7	90.2
10–14	2.4	2.3	11.2	10.2	1.5	1.8	19.8	26.9	14.9	17.9	5.5	6.4	59.6	43.3
15–19	3.5	3.8	61.1	101.5	2.6	3.1	23.1	34.1	27.9	33.2	7.7	5.6	91.3	62.9
20–24	5.2	5.8	147.6	216.3	5.3	6.1	25.8	26.8	26.6	42.0	14.4	15.2	118.7	96.9
25–44......	7.6	10.1	185.2	352.0	14.9	18.6	51.1	65.0	67.0	92.1	42.3	64.7	128.3	110.0
45–64	18.5	22.1	174.1	262.1	134.5	150.0	232.5	316.3	166.0	189.6	205.5	267.2	151.1	128.9
65–84	76.4	78.7	189.3	161.4	451.4	533.6	1472.7	1693.7	498.2	607.6	842.5	952.2	250.5	233.5
85 and over .	273.2	271.1	60.0	69.3	869.6	900.7	4377.8	4873.0	1739.1	1824.5	1919.0	2355.7	839.6	970.0
Unknown...	....	....	....	....	....	....	....	....	....	....	....	....	....	....
FEMALES														
All ages	14.0	14.3	98.8	109.6	72.8	81.0	106.4	123.3	143.4	168.1	62.7	78.1	37.9	34.9
Under 10 ...	23.8	23.7	19.1	20.6	2.8	2.2	22.7	20.9	333.1	396.6	7.8	7.4	64.9	55.1
10–14	2.2	2.3	19.3	27.1	1.8	2.7	26.4	29.8	16.0	20.3	8.0	7.4	11.4	10.6
15–19	3.2	3.2	91.5	111.5	2.6	3.9	21.7	25.5	14.0	22.4	8.6	8.8	14.0	11.5
20–24	4.5	4.9	162.3	186.3	1.4	4.0	22.1	29.1	20.3	21.7	16.1	15.4	12.5	15.1
25–44	6.5	7.4	172.8	193.3	41.4	50.9	47.7	61.8	35.9	54.2	38.5	59.2	13.2	14.5
45–64	15.2	16.6	108.9	111.1	251.0	287.4	220.8	247.1	119.4	130.3	155.9	208.6	29.0	28.8
65–84	68.7	68.7	178.7	137.9	649.1	668.4	1167.5	1369.3	607.8	683.4	606.9	680.9	193.9	193.8
85 and over .	271.3	248.2	100.9	32.6	827.1	896.2	3389.1	3992.2	2077.9	2362.7	1573.5	1694.6	1452.5	1319.9
Unknown...	....	....	....	....	....	....	....	....	....	....	....	....	....	....

TABLE V

DEATH RATES OF PERSONS BORN IN AUSTRIA-HUNGARY, FOR THE PRINCIPAL CAUSES OF DEATH, BY SEX AND BY AGE PERIOD. PENNSYLVANIA AND NEW YORK STATE, 1910

Sex and age period	All causes		Tuberculosis of lungs		Cancer		Organic heart diseases		Pneumonia		Bright's disease		Violence excl. suicide	
	Rate per 1,000		Rate per 100,000		Rate per 100,000		Rate per 100,000		Rate per 100,000		Rate per 100,000		Rate per 100,000	
	Pa.	N. Y.	Pa.	N. Y.	Pa.	N. Y.	Pa.	N. Y.	Pa.	N. Y.	Pa.	N. Y.	Pa.	N. Y.
MALES														
All ages	9.7	9.3	118.0	166.0	31.9	64.9	57.0	86.4	90.9	80.7	37.5	92.0	341.6	121.4
Under 10 ...	11.6	7.4	13.8	16.7	....	16.7	13.8	....	193.3	167.3	....	16.7	110.5	100.4
10–14	3.0	2.8	35.5	14.1	....	....	17.7	28.3	....	14.1	17.7	....	70.9	113.1
15–19	5.5	4.1	55.4	102.4	6.2	7.3	12.3	29.3	61.6	43.9	6.2	14.6	270.9	102.4
20–24	7.1	4.3	106.5	93.1	2.3	14.3	11.6	17.9	53.3	32.2	6.9	3.6	335.8	139.7
25–44	8.5	6.7	110.6	177.2	16.0	20.3	44.6	49.1	70.6	43.8	17.3	35.2	357.1	119.5
45–64......	22.3	21.0	264.2	302.5	168.5	259.8	203.0	244.3	260.4	228.8	199.1	298.6	425.1	112.5
65–84	63.9	77.5	242.7	247.9	809.1	779.0	1132.7	1062.3	485.4	566.6	809.1	1628.9	566.3	283.3
85 and over .	181.8	301.6	....	....	....	1587.3	....	4761.9	4545.5	3174.6	4545.5	4761.9	9090.9	....
Unknown...	....	....	....	....	....	....	....	....	....	....	....	....	....	....
FEMALES														
All ages	8.0	7.4	130.2	102.6	48.2	83.8	67.5	77.1	71.5	68.6	37.0	67.4	29.7	23.1
Under 10 ...	12.3	8.2	27.4	....	....	....	27.4	16.6	178.3	199.6	....	....	96.0	33.3
10–14	1.7	1.6	17.3	13.7	....	....	....	41.1	17.3	13.7	17.3	....	....	....
15–19	4.0	2.0	74.2	49.6	....	4.5	16.5	4.5	41.2	18.0	8.2	4.5	16.5	18.0
20–24	5.9	3.5	141.2	87.9	12.1	3.0	12.1	30.3	60.5	24.3	8.1	12.1	36.3	9.1
25–44	7.1	5.8	152.7	137.2	38.2	46.6	57.3	43.9	55.7	43.9	28.6	37.0	20.7	17.8
45–64	16.7	18.2	162.3	122.9	229.2	393.4	191.0	221.3	105.0	172.1	210.1	241.0	9.5	49.2
65–84	75.5	63.9	215.7	142.1	970.9	746.0	2265.3	1136.8	970.9	639.4	215.7	852.6	539.4	177.6
85 and over .	114.3	213.5	....	....	....	1123.6	....	3370.8	....	2247.2	....	5618.0	....	....
Unknown...	....	....	....	....	....	....	....	....	....	....	....	....	....	....

General death rates such as we have just noticed are after all but a composite of the rates for the individual causes of death. It is instructive, therefore, to consider the above findings as to the mortality of persons born in Austria-Hungary and living in Pennsylvania and in New York in the light of the principal diseases and conditions causing death. It is necessary, unfortunately, to compare the facts for each of the foreign born nationalities with the corresponding figures for the entire group of the native born without distinction of parentage (Table IV). As compared with these rates, we have the figures (Table V) for persons born in Austria-Hungary and residing in Pennsylvania and in New York.

On examining the causes of death among the Austro-Hungarians, we find that in each state their rates from pulmonary tuberculosis are lower than those for the native born at ages 20 to 44, while at 45–64 they are higher. This observation holds for both sexes. For males in both states and for females in New York, natives of Austria-Hungary show higher cancer rates at ages 45 to 84 than do native Americans, while exactly the reverse is true for organic heart diseases. In New York, rates for Bright's disease are higher at ages 45 to 84 among Austro-Hungarians of both sexes than among the native born.

The most important cause of death among Austro-Hungarian males in Pennsylvania is violence (excluding suicide). This may be attributed to the perilous and unskilled occupations in which these immigrants engage. Throughout the entire working period of life (15 to 64), the death rates among Austro-Hungarians from this cause are about three times as high as among natives.

RUSSIANS

Next in importance among the foreign born in Pennsylvania are the Russians. These, too, are comparatively recent immigrants to this country, but they have increased by leaps and bounds since 1890. In 1910, there were in Pennsylvania 240,980 persons born in Russia, forming 16.7 per cent of the total foreign born whites and 3.2 per cent of the total white population. In New York State, there were, in 1910, 558,952 Russian born persons, constituting 20.5 per cent of the foreign born and 6.2 per cent of the total white population.

Here, too, we are dealing with a heterogeneous group which includes a large proportion of Jews as well as Poles and true Russians. Of all the Russian immigrants to the United States in the period 1899–1910, 43.8 per cent were Jews, and it is very probable that a much larger proportion of the Russians in New York State in 1910 were Jews. This is an important point to keep in mind, because the Jews usually show a lower mortality than the races among which they live. This fact has been reported independently by many observers. With the restriction in mind, then, that our figures for Russians are really for a group composed mainly of Jews, we present Table VI for the states of Pennsylvania and New York, 1910:

TABLE VI

DEATHS PER 1,000 WHITE POPULATION AMONG PERSONS BORN IN RUSSIA, AND AMONG NATIVE BORN OF NATIVE PARENTAGE, BY SEX AND BY AGE PERIOD; PENNSYLVANIA AND NEW YORK STATE, 1910

Sex and age period	Pennsylvania		New York	
	Native born of native parentage	Russian born	Native born of native parentage	Russian born
Males				
All ages:				
Crude rate	14.2	9.3	15.9	7.5
Ages 10 and over:				
Crude rate	11.5	9.3	13.8	7.7
Standardized rate	12.8	13.7	13.8	13.1
Under 10	22.6	9.7	23.5	4.4
10–14	2.3	2.0	2.5	1.6
15–19	3.3	5.1	3.6	2.6
20–24	4.9	6.1	5.0	3.8
25–44	6.2	8.0	6.9	5.1
45–64	16.8	21.6	18.8	20.1
65–84	75.2	61.7	77.3	78.4
85 and over	253.0	216.2	268.9	255.8
Females				
All ages:				
Crude rate	12.7	7.3	13.9	6.6
Ages 10 and over:				
Crude rate	10.9	7.1	12.4	6.8
Standardized rate	12.3	12.7	12.4	12.3
Under 10	18.6	9.9	19.6	3.7
10–14	2.3	2.3	2.6	1.4
15–19	3.3	2.9	3.2	1.8
20–24	4.2	4.1	4.7	2.9
25–44	5.8	6.3	5.7	5.3
45–64	14.4	14.1	14.3	16.0
65–84	66.6	68.8	68.2	69.8
85 and over	253.8	317.1	242.3	257.8

Disregarding the figures for the period under 10, we find that in Pennsylvania, Russian males reflect the serious hazards under which they work. Their death rates are much higher than those for the native born of native parentage at ages 15 to 64; females of the two groups in Pennsylvania do not show this difference so markedly. In New York, on the other hand, the death rates for Russians of both sexes are appreciably lower than those for the native stock at ages 10 to 44. Similar differences are observed when we consider the standardized rates for age 10 and over, the rates per 1,000 Russian males in Pennsylvania and New York being 13.7 and 13.1, respectively, as compared with 12.8 and 13.8 for the native stock.

Table VII presents death rates of Russian born persons in Pennsylvania and New York by the principal causes of death.

There is a much lower mortality from pulmonary tuberculosis among Russians than among the native born. In the age period 25–44, for example, Russian males in New York had a tuberculosis rate of 117.1 per 100,000, as against 352.0 among the native born; for Russian females, the rate was 104.7 as against 193.3. The direct relationship between the low tuberculosis mortality and the large representation of Jews among the Russian born is unmistakable. This conclusion agrees with the work of others who have studied the mortality from tuberculosis among Jews in other countries.

The cancer rate is higher among Russian males in New York in the period 45–64, the rates being 277.5 as against 150.0 per 100,000 for the native born. Russian females in Pennsylvania have a cancer rate of 326.0 at 45–64, as contrasted with 251.0 for natives, and at 65–84 a rate of 1161.8 against 649.1 for the native born. In both sexes at age periods 45 to 84, the mortality from pneumonia (all forms) is greater among Russians than for native Americans. Thus, Russian males in Pennsylvania have a pneumonia rate at 45–64 of 237.2, while that for the natives is but 166.0. In New York, the corresponding figures are 228.2 and 189.6, for the Russians and native born, respectively.

Very high rates from violence are found among Russian males in Pennsylvania; in fact, they are close to three times as

TABLE VII

DEATH RATES OF PERSONS BORN IN RUSSIA, FOR THE PRINCIPAL CAUSES OF DEATH, BY SEX AND BY AGE PERIOD. PENNSYLVANIA AND NEW YORK STATE, 1910

Sex and age period	All causes		Tuberculosis of lungs		Cancer		Organic heart diseases		Pneumonia		Bright's disease		Violence excl. suicide	
	Rate per 1,000		Rate per 100,000		Rate per 100,000		Rate per 100,000		Rate per 100,000		Rate per 100,000		Rate per 100,000	
	Pa.	N. Y.	Pa.	N. Y.	Pa.	N. Y.	Pa.	N. Y.	Pa.	N. Y.	Pa.	N. Y.	Pa.	N. Y.
MALES														
All ages	9.3	7.5	107.4	114.7	43.1	69.0	65.0	78.9	84.2	81.2	53.4	65.4	288.1	68.7
Under 10	9.7	4.4	15.4	23.5	....	....	15.4	5.9	138.8	70.4	30.9	5.9	61.7	70.4
10–14	2.0	1.6	....	11.7	....	....	16.6	29.2	16.6	17.5	16.6	11.7	66.3	35.0
15–19	5.1	2.6	69.6	60.5	....	....	....	30.3	49.7	11.3	9.9	3.8	238.5	30.3
20–24	6.1	3.8	99.6	96.4	4.0	13.5	15.9	11.6	27.9	36.6	4.0	5.8	314.8	84.8
25–44	8.0	5.1	105.9	117.1	31.2	34.3	39.9	40.4	67.3	51.2	34.9	24.2	312.9	65.3
45–64	21.6	20.1	225.1	246.4	188.6	277.5	279.8	254.2	237.2	228.2	170.3	238.6	334.6	80.4
65–84	61.7	78.4	148.7	182.4	446.1	1026.0	817.8	1254.0	520.4	1003.2	1115.2	1322.4	297.4	205.2
85 and over	216.2	255.8	....	....	....	....	....	5426.4	2702.7	1550.4	5405.4	4651.2	....	2325.6
Unknown	....	....	....	....	....	....	....	....	....	....	....	....	....	....
FEMALES														
All ages	7.3	6.6	91.7	74.6	67.5	69.5	65.4	85.2	67.5	60.1	38.0	72.3	38.0	24.3
Under 10	9.9	3.7	31.3	....	....	....	15.7	11.9	203.6	83.3	....	....	47.0	35.7
10–14	2.3	1.4	....	5.7	....	....	16.5	40.1	16.5	22.9	16.5	....	16.5	11.5
15–19	2.9	1.8	70.9	28.0	....	3.1	10.1	9.3	10.1	15.5	20.2	....	40.5	15.5
20–24	4.1	2.9	92.6	88.7	5.8	2.1	40.5	30.9	5.8	14.4	5.8	12.4	28.9	12.4
25–44	6.3	5.3	108.0	104.7	32.2	55.3	48.3	43.6	55.1	33.0	29.9	31.0	32.2	18.4
45–64	14.1	16.0	124.6	80.8	326.0	286.1	163.0	239.4	134.2	158.6	115.0	276.7	57.5	43.5
65–84	68.8	69.8	178.7	94.3	1161.8	613.2	1072.4	1485.8	714.9	801.9	625.6	1273.6	268.1	188.7
85 and over	317.1	257.8	....	....	4878.0	....	4878.0	4687.5	4878.0	3906.3	....	2343.8	....	1562.5
Unknown	....	....	....	....	....	....	....	....	....	....	....	....	....	....

high as for the native born. In New York, the rates from violence are low among Russian born. We see here the effect of different industrial conditions.

There are no recent authentic figures of mortality for persons living in Russia and, therefore, no comparisons can be made between them and Russians living in the United States.

ITALIANS

Italians in America are much more homogeneous than the Austro-Hungarians or Russians. According to the 1910 census, the number of persons of Italian birth in Pennsylvania was 196,122. This was 13.6 per cent of the foreign born white and 2.6 per cent of the total white population in the state. In New York, Italian born persons numbered 472,192, constituting 17.3 per cent of the foreign born whites and 5.3 per cent of the total white population. The bulk of Italian immigration into America has been since 1890.

Table VIII presents the death rates of Italian born persons living in Pennsylvania and New York compared with the rates for the native stock.

Beginning with age 15 and continuing through 64, the death rates for Italian born males and females are higher than those for the native stock, the single exception being in the case of males in New York at ages 25–44. This Italian excess is especially marked in Pennsylvania, due probably to conditions under which they work. It is interesting to observe that Italian females in New York State show, from ages 10 to 44, a higher mortality than the males, and the facts are similar among Italians in their own country. The standardized rates at ages 10 and over indicate that, except for males in New York State, persons of Italian birth have slightly higher mortality rates than the native born of native parents.

Among Italian males in both states, the most important cause of death is violence (excluding suicide). This fact alone is sufficient to account for the unfavorable conditions among Italian males in Pennsylvania; at every age period from 15 to 64, their rates are from two and one-half to three times higher than for native Americans. The excess among Italians in New York at these ages is much less. These relations are clearly shown in Table IX in conjunction with Table IV.

TABLE VIII

DEATHS PER 1,000 WHITE POPULATION AMONG PERSONS BORN IN ITALY, AND AMONG NATIVE BORN OF NATIVE PARENTAGE, BY SEX AND BY AGE PERIOD. PENNSYLVANIA AND NEW YORK STATE, 1910

Sex and age period	Pennsylvania		New York	
	Native born of native parentage	Italian born	Native born of native parentage	Italian born
MALES				
All ages:				
Crude rate	14.2	9.8	15.9	9.2
Ages 10 and over:				
Crude rate	11.5	9.7	13.8	9.0
Standardized rate	12.8	14.5	13.8	12.9
Under 10	22.6	11.5	23.5	13.1
10–14	2.3	3.5	2.5	2.7
15–19	3.3	8.3	3.6	5.5
20–24	4.9	7.7	5.0	6.2
25–44	6.2	8.1	6.9	6.6
45–64	16.8	19.7	18.8	19.3
65–84	75.2	71.3	77.3	64.6
85 and over	253.0	100.0	268.9	120.3
FEMALES				
All ages:				
Crude rate	12.7	9.0	13.9	9.7
Ages 10 and over:				
Crude rate	10.9	8.8	12.4	9.5
Standardized rate	12.3	12.6	12.4	13.7
Under 10	18.6	11.3	19.6	12.7
10–14	2.3	2.0	2.6	3.4
15–19	3.3	5.1	3.2	5.7
20–24	4.2	5.3	4.7	6.1
25–44	5.8	7.9	5.7	7.0
45–64	14.4	14.6	14.3	17.9
65–84	66.6	60.9	68.2	63.8
85 and over	253.8	176.5	242.3	214.3

Italian males in both states between ages 20 and 64 are at a decided advantage as to pulmonary tuberculosis. Among the women in New York State, however, conditions are quite different at the younger ages. For example, at ages 15–19 and 20–24, the death rates from pulmonary tuberculosis are 220.6 and 247.7 among Italian women, as contrasted to 111.5 and 186.3, respectively, among native American women. In respect to organic diseases of the heart, men show lower rates at the important ages 25 to 84. This is again in contrast to conditions among women, who, at ages 45 to 84, compare unfavorably with native Americans. Pneumonia, all forms,

TABLE IX

DEATH RATES OF PERSONS BORN IN ITALY, FOR THE PRINCIPAL CAUSES OF DEATH, BY SEX AND BY AGE PERIOD. PENNSYLVANIA AND NEW YORK STATE, 1910

Sex and age period	All causes		Tuberculosis of the lungs		Cancer		Organic heart diseases		Pneumonia		Bright's disease		Violence (excl. suicide)	
	Rate per 1,000		Rate per 100,000		Rate per 100,000		Rate per 100,000		Rate per 100,000		Rate per 100,000		Rate per 100,000	
	Pa.	N. Y.	Pa.	N. Y.	Pa.	N. Y.	Pa.	N. Y.	Pa.	N. Y.	Pa.	N. Y.	Pa.	N. Y.
MALES														
All ages	9.8	9.2	81.5	112.1	26.2	31.9	51.7	79.5	135.4	153.4	29.8	54.3	311.5	158.4
Under 10 ...	11.5	13.1	19.9	8.3	....	....	19.9	....	198.8	364.5	19.9	....	59.7	174.0
10–14	3.5	2.7	23.0	15.1	....	....	....	22.7	92.2	37.8	....	7.6	92.2	83.3
15–19	8.3	5.5	43.4	106.8	....	....	17.4	15.8	130.2	71.2	26.0	....	364.7	162.2
20–24	7.7	6.2	86.5	140.4	3.9	6.5	11.8	10.8	110.1	88.5	....	13.0	342.0	170.6
25–44	8.1	6.6	71.2	102.0	12.1	15.4	35.0	41.2	92.8	85.2	13.5	31.4	324.3	155.8
45–64	19.7	19.3	154.3	172.9	127.4	124.2	161.0	250.8	348.8	394.5	127.4	172.9	335.3	168.0
65–84	71.3	64.6	631.8	208.5	631.8	364.9	1263.5	1303.1	722.0	1198.9	722.0	807.9	90.3	156.4
85 and over..	100.0	120.3	....	....	....	....	250.0	2255.6	....	....	....	751.9	....	1503.8
Unknown...	....	....	....	....	....	....	....	....	....	....	....	....	....	....
FEMALES														
All ages	9.0	9.7	102.2	160.1	66.4	57.8	93.6	134.9	103.9	145.6	51.1	65.3	30.6	32.1
Under 10 ...	11.3	12.7	42.0	34.0	21.0	....	42.0	8.5	209.8	391.4	....	....	83.9	153.2
10–14	2.0	3.4	....	89.1	....	....	50.3	48.6	25.1	32.4	....	....	25.1	24.3
15–19	5.1	5.7	102.0	220.6	....	....	61.2	30.1	61.2	50.1	....	10.0	20.4	25.1
20–24	5.3	6.1	153.6	247.7	....	....	23.6	50.9	35.4	57.7	23.6	6.8	....	20.4
25–44	7.9	7.0	114.8	159.3	53.8	35.8	43.0	65.4	78.9	81.5	21.5	39.5	39.5	16.1
45–64	14.6	17.9	77.7	123.3	259.0	239.6	259.0	373.6	181.3	253.7	168.4	211.5	13.0	45.8
65–84	60.9	63.8	217.3	55.4	326.1	274.9	1413.0	1649.3	760.9	1429.4	978.3	549.8	....	55.0
85 and over..	176.5	214.3	....	793.7	....	....	2941.2	3968.3	2941.2	3968.3	....	4761.9	....	....
Unknown...	....	....	....	....	....	....	....	....	....	....	....	....	....	....

is especially prominent among Italians. In practically every age period from 20 to 84, their rates are higher than those of the native.

Italians in Pennsylvania and New York State show, on the whole, little difference in their death rates from those prevailing in their home country. A slight excess, which is apparent at some age periods in the American figures for Italian males, is very likely the result of the hazardous employment in which they are engaged. It is interesting, also, to note that the death rates from pneumonia in Italy are lower than among Italians in this country at ages 25 to 64 for males and females.*

GERMANS

In the three foreign born groups thus far examined (Austro-Hungarians, Russians, and Italians), we have found mortality conditions which, when compared with those for the native born, are, on the whole, favorable, except in so far as the greater industrial hazards to which these foreign groups are exposed operate to increase their mortality from accidental violence. We come now to the consideration of three groups of the foreign born whose position relative to the native born is very unfavorable, even apart from deaths from accident: the Germans, British, and Irish. Their death rates in the United States are in each case less favorable than in their native land. Of these three groups, those of German birth were of the greatest relative importance in Pennsylvania and New York. In Pennsylvania, they numbered 195,185, constituting 13.6 per cent of the foreign born white and 2.6 per cent of the total white population; and, in New York State, they were represented by 436,874 persons, being 16.0 per cent of the foreign born white and 4.9 per cent of the total white population. The Germans were one of the most important elements of the earlier immigration into the United States. From 1850 to 1870, they formed the second largest component of the foreign born population in this country, being exceeded only by the Irish; and from 1880 onwards they have occupied the first rank at each census. Table X presents death rates for German born persons living in Pennsylvania and New York, by sex and age period, 1910.

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* Ufficio Centrale di Statistica, *Statistica Della Cause di Morte*, Rome, 1914, p. 44 *et seq.*

TABLE X

DEATHS PER 1,000 WHITE POPULATION AMONG PERSONS BORN IN GERMANY, AND AMONG NATIVE BORN OF NATIVE PARENTAGE, BY SEX AND BY AGE PERIOD. PENNSYLVANIA AND NEW YORK STATE, 1910

Sex and age period	Pennsylvania		New York	
	Native born of native parentage	German born	Native born of native parentage	German born
MALES				
All ages:				
Crude rate	14.2	28.2	15.9	27.5
Ages 10 and over:				
Crude rate	11.5	28.4	13.8	27.7
Standardized rate	12.8	17.0	13.8	17.9
Under 10	22.6	13.3	23.5	12.7
10–14	2.3	3.0	2.5	5.8
15–19	3.3	4.1	3.6	3.4
20–24	4.9	8.2	5.0	4.5
25–44	6.2	9.0	6.9	10.0
45–64	16.8	23.0	18.8	27.7
65–84	75.2	93.7	77.3	90.4
85 and over	253.0	284.7	268.9	263.4
FEMALES				
All ages:				
Crude rate	12.7	23.5	13.9	22.6
Ages 10 and over:				
Crude rate	10.9	23.8	12.4	22.8
Standardized rate	12.3	14.2	12.4	14.4
Under 10	18.6	9.4	19.6	10.3
10–14	2.3	1.5	2.6	1.6
15–19	3.3	3.5	3.2	2.7
20–24	4.2	4.4	4.7	4.0
25–44	5.8	6.4	5.7	6.3
45–64	14.4	18.5	14.3	18.4
65–84	66.6	77.8	68.2	83.1
85 and over	253.8	279.0	242.3	246.4

Because of the reduction of German immigration in recent years, it is necessary to begin with ages 25–44. The rates are very much higher than for the native stock, and this condition continues throughout life. Considering together ages 10 and over, the rates, when standardized for age as above outlined, are, for males, 17.0 and 17.9 in Pennsylvania and New York, respectively, against 12.8 and 13.8 for the native stock; and for females 14.2 in Pennsylvania and 14.4 in New York, as contrasted to 12.3 and 12.4, respectively, for the native stock. The rates for Germans in both states are thus distinctly higher than the rates for the natives, the excess being more marked for males than for females.

The rates for Germans at home are more favorable than for Germans in this country. Thus, the death rate for males in Germany at 25–44 was 6.4 per 1,000 in 1908–13,* as against 9.0 and 10.0 for Germans in Pennsylvania and New York, respectively, in 1910; at 45–64 German males at home showed a rate of 21.3 per 1,000, contrasted with 23.0 and 27.7 in Pennsylvania and New York; while at ages 65–84, their rate in Germany was 84.5 as compared with 93.7 and 90.4 in the two states. Among females, the German excess in this country is less marked.

In seeking to determine the causes for the high mortality of Germans in America, we find (Table XI) that the pulmonary affections and the so-called "degenerative" diseases are to a large degree responsible.

At most of the age periods, the rates for pulmonary tuberculosis among German males are greatly in excess of those of native Americans; for example, at ages 45–64, there are mortality rates of 230.3 and 350.0 per 100,000 among Germans in Pennsylvania and New York from this cause; while the corresponding rates for native born males are 174.1 in Pennsylvania and 262.1 in New York. The position of the German born women with regard to pulmonary tuberculosis is very favorable.

The incidence of pneumonia is high among persons of German birth in both states, their disadvantage from this cause being especially marked at ages 65–84. For example, at this period in life the rates per 100,000 German males in Pennsylvania and New York are 917.2 and 806.6, respectively, as contrasted with 498.2 and 607.6 for native born males. Cancer is more frequent as a cause of death among German males at ages 45 to 84, and among German females at ages 25 to 84. The differences are strikingly large among males; at ages 45–64, for example, the cancer mortality per 100,000 German males is 251.0 and 291.3 in Pennsylvania and New York, respectively, while that of natives is but 134.5 in Pennsylvania and 150.0 in New York. Almost without exception, the rates for organic heart disease and Bright's disease among German born persons, of both sexes, living in Pennsylvania and New York, are higher

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* Institut International de Statistique, *Annuaire International de Statistique:* I. Etat (p. 45), and II. Mouvement (p. 75) de la population (Europe). La Hague, 1916–17.

TABLE XI

DEATH RATES OF PERSONS BORN IN GERMANY, FOR THE PRINCIPAL CAUSES OF DEATH, BY SEX AND BY AGE PERIOD. PENNSYLVANIA AND NEW YORK STATE, 1910

Sex and age period	All causes		Tuberculosis of lungs		Cancer		Organic heart diseases		Pneumonia		Bright's disease		Suicides	
	Rate per 1,000		Rate per 100,000		Rate per 100,000		Rate per 100,000		Rate per 100,000		Rate per 100,000		Rate per 100,000	
	Pa.	N. Y.	Pa.	N. Y.	Pa.	N. Y	Pa.	N. Y.	Pa.	N. Y.	Pa.	N. Y.	Pa.	N. Y.
MALES														
All ages	28.2	27.5	194.9	267.4	186.7	222.1	433.8	419.3	293.4	254.9	300.4	334.9	80.0	91.9
Under 10 ...	13.3	12.7	147.9	....	....	....	....	....	74.0	423.1	....	....	....	....
10–14	3.0	5.8	....	52.8	....	....	....	158.4	....	....	....	52.3	74.4	....
15–19	4.1	3.4	....	90.8	....	....	45.4	....	45.4	....	....	22.7	....	....
20–24	8.2	4.5	211.3	45.9	....	....	42.3	....	42.3	45.9	42.3	9.2	....	36.7
25–44	9.0	10.0	198.2	252.5	10.7	40.4	72.3	75.4	112.5	94.0	32.1	67.8	56.3	53.6
45–64	23.0	27.7	230.3	350.0	251.0	291.3	292.4	328.9	269.1	269.0	230.3	332.4	95.6	131.6
65–84	93.7	90.4	140.6	211.3	589.2	732.6	1841.1	1905.5	917.2	806.6	1272.1	1306.7	140.6	137.4
85 and over .	284.7	263.4	180.2	210.7	....	737.6	3783.8	5374.1	1801.8	1896.7	1982.0	3582.7	180.2	316.1
Unknown...	....	....	....	....	....	....	....	....	....	....	....	.....	....	....
FEMALES														
All ages	23.5	22.6	90.4	115.3	256.4	264.5	379.8	396.8	214.9	205.0	210.7	274.4	20.2	22.2
Under 10 ...	9.4	10.3	....	51.7	....	....	72.6	....	145.2	155.0	....	....	....	....
10–14	1.5	1.6	....	....	....	....	72.6	53.6	....	....	....	....	....	....
15–19	3.5	2.7	39.1	76.9	....	19.2	39.1	19.2	....	38.4	....	19.2	....	19.2
20–24	4.4	4.0	128.0	158.2	18.3	....	....	15.8	18.3	15.8	....	7.9	....	31.6
25–44	6.4	6.3	106.2	125.1	58.7	81.4	69.8	40.1	30.7	44.8	33.5	43.6	14.0	13.0
45–64	18.5	18.4	85.4	109.7	351.0	333.2	287.7	288.5	167.6	136.8	186.6	245.2	25.3	27.1
65–84	77.8	83.1	72.9	106.3	709.5	773.7	1472.1	1766.5	782.4	840.1	729.4	1122.3	33.2	33.2
85 and over .	279.0	246.4	156.7	80.3	156.7	882.8	2507.8	4574.6	2664.6	2728.7	2664.6	1765.7	156.7	80.3
Unknown ..	....	....	....	....	....	....	....	....	....	....	....	....	....	....

from ages 25 onward than are the corresponding rates for native born Americans. Suicide is also an important cause of death among German males—an observation already made by a number of writers relative to Germans in their own country, and the rates are much in excess of those for the native stock.

ENGLISH, SCOTCH, WELSH (BRITISH)

Persons of British nativity were an important component of the earlier immigration into the United States, although in recent years they have been a very small part of the stream of newcomers. In 1850, they constituted 16.9 per cent of the total foreign born, but have declined in relative importance until in 1910 they were only 9.0 per cent. In Pennsylvania at the 1910 census, there were 170,356 persons born in Great Britain, or 11.8 per cent of the white foreign born, and 2.3 per cent of the total white population. In New York, they numbered 193,359, or 7.1 per cent of the foreign born and 2.2 per cent of the total white population.

The group as a whole shows high death rates when compared with the native stock. This is true of both males and females and in both states. At the ages 25 to 64, the disadvantage against the British is nearly 50 per cent. The standardized rates after age 10 are better in Pennsylvania than in New York, but even in the former state the advantage of the natives is considerable. The figures are given in Table XII.

It is difficult to understand this condition of unfavorable mortality in view of the fact that the rates for the British in their own country are among the most favorable in Europe. In the last censal year (1911), the death rate per 1,000 males aged 25–44 in England and Wales* was 6.4, as against 8.4 and 8.7 for British born males living in Pennsylvania and New York, respectively; at 45–64, British males at home showed a rate of 20.5 per 1,000, compared with 24.0 in Pennsylvania and 24.6 in New York. The conditions among females are similar.

The causes of death (Table XIII) which are responsible for the unfavorable position of the British in the United States as compared with the native born are many.

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*Seventy-fourth Annual Report of the Registrar-General for England and Wales (1911), pp. 61, 62.

TABLE XII

DEATHS PER 1,000 WHITE POPULATION AMONG PERSONS BORN IN ENGLAND, SCOTLAND, AND WALES, AND AMONG NATIVE BORN OF NATIVE PARENTAGE, BY SEX AND BY AGE PERIOD. PENNSYLVANIA AND NEW YORK STATE, 1910

Sex and age period	Pennsylvania		New York	
	Native born of native parentage	English, Scotch and Welsh born	Native born of native parentage	English, Scotch and Welsh born
Males				
All ages:				
Crude rate	14.2	21.5	15.9	21.8
Ages 10 and over:				
Crude rate	11.5	21.8	13.8	22.6
Standardized rate	12.8	16.1	13.8	16.6
Under 10	22.6	11.0	23.5	7.0
10–14	2.3	2.7	2.5	3.7
15–19	3.3	4.4	3.6	5.8
20–24	4.9	5.3	5.0	4.3
25–44	6.2	8.4	6.9	8.7
45–64	16.8	24.0	18.8	24.6
65–84	75.2	84.2	77.3	86.6
85 and over	253.0	298.6	268.9	261.9
Females				
All ages:				
Crude rate	12.7	19.5	13.9	20.6
Ages 10 and over:				
Crude rate	10.9	19.8	12.4	20.8
Standardized rate	12.3	15.1	12.4	15.8
Under 10	18.6	8.7	19.6	6.0
10–14	2.3	2.3	2.6	3.3
15–19	3.3	2.5	3.2	5.8
20–24	4.2	6.0	4.7	3.8
25–44	5.8	7.8	5.7	7.6
45–64	14.4	18.1	14.3	21.0
65–84	66.6	81.2	68.2	79.9
85 and over	253.8	283.0	242.3	279.6

Pneumonia is more prevalent among British born males and females at ages 25 to 84 than among natives. Among British males in Pennsylvania at ages 45–64, for example, there is a mortality from this cause of 343.5 per 100,000, but of only 166.0 among native Americans. Similarly, at ages 65–84, the death rates from pneumonia are 758.9 and 498.2 for the British and native born, respectively. Cancer is higher among British males from 45 to 84, and among British females at 25 to 84. Thus, there is a rate at ages 45–64 of 239.7 per 100,000 British males in New York, in contrast with 150.0 among native males; among British females, it is 360.9, while that of

TABLE XIII

DEATH RATES OF PERSONS BORN IN ENGLAND, SCOTLAND, AND WALES, FOR THE PRINCIPAL CAUSES OF DEATH, BY SEX AND AGE PERIOD. PENNSYLVANIA AND NEW YORK STATE, 1910

Sex and age period	All causes		Tuberculosis of lungs		Cancer		Organic heart diseases		Pneumonia		Bright's disease		Violence excl. suicide	
	Rate per 1,000		Rate per 100,000		Rate per 100,000		Rate per 100,000		Rate per 100,000		Rate per 100,000		Rate per 100,000	
	Pa.	N. Y.	Pa.	N. Y.	Pa.	N. Y.	Pa.	N. Y.	Pa.	N. Y.	Pa.	N. Y.	Pa.	N. Y.
MALES All ages	21.5	21.8	150.2	215.2	124.2	145.5	306.1	325.3	245.1	203.4	208.9	201.5	225.9	163.1
Under 10 ...	11.0	7.0	....	23.4	....	....	....	....	122.4	163.8	....	....	204.0	....
10–14	2.7	3.7	....	36.9	....	....	....	110.6	....	....	....	....	54.2	184.4
15–19	4.4	5.8	120.3	128.7	....	64.4	....	32.2	....	32.2	....	....	160.4	128.7
20–24	5.3	4.3	59.3	71.5	19.8	14.3	59.3	....	59.3	14.3	19.8	....	217.6	114.4
25–44	8.4	8.7	151.5	240.5	21.6	13.9	67.6	69.4	94.7	99.4	43.3	46.3	219.1	138.8
45–64	24.0	24.6	165.3	268.9	152.3	239.7	340.3	272.1	343.5	252.7	239.8	288.3	243.1	178.2
65–84	84.2	86.6	233.5	210.3	630.5	590.9	1447.8	1903.0	758.9	701.1	1004.1	861.4	256.9	290.5
85 and over .	298.6	261.9	....	....	....	1237.1	6334.9	4742.3	2262.4	1443.3	3619.9	2061.9	452.5	824.7
Unknown...	....	....	....	....	....	....	....	....	....	....	....	....	....	....
FEMALES All ages ...	19.5	20.6	133.2	123.3	220.0	223.8	255.5	341.7	165.0	205.2	183.3	192.1	62.3	61.1
Under 10 ...	8.7	6.0	41.6	23.2	....	23.2	....	23.2	124.8	46.4	....	....	83.2	....
10–14	2.3	3.3	....	....	....	....	....	146.7	....	....	....	....	....	....
15–19	2.5	5.8	84.4	64.0	....	....	42.2	32.0	....	96.0	....	....	....	....
20–24	6.0	3.8	80.4	121.5	20.1	....	20.1	60.7	120.6	30.4	....	15.2	....	....
25–44	7.8	7.6	166.9	165.4	83.4	57.8	63.3	52.5	63.3	55.1	46.0	49.9	23.0	21.0
45–64	18.1	21.0	112.2	92.1	318.0	360.9	217.0	295.6	160.9	199.7	209.5	241.9	29.9	57.6
65–84	81.2	79.9	153.7	139.3	744.9	855.9	1383.3	1791.4	614.8	826.0	851.3	826.0	271.9	258.8
85 and over .	283.0	279.6	314.5	164.5	628.9	328.9	3144.6	4276.3	2830.2	4111.8	1886.8	1644.7	3144.6	822.4
Unknown...	....	....	....	....	....	....	....	....	....	....	....	....	....	....

natives is but 287.4. Bright's disease is likewise more prevalent among British females at ages 45 to 84. The death rate from violence (excluding suicide) is higher in both states among British males 20 to 84 than among native Americans.

It is largely these same causes which are responsible for the disadvantage which the British born living in the United States exhibit when compared with their countrymen at home. For example, at ages 45–64, males in England and Wales had in 1911 a pneumonia rate of 150.7 per 100,000, as against 343.5 and 252.7 for British born males living in Pennsylvania and New York, respectively; and at the same age period (45–64) females have a pneumonia rate of 76.6 per 100,000 in England and Wales, contrasted with 160.9 and 199.7 for British born females living in Pennsylvania and New York. The facts for Bright's disease are even more striking. At ages 45–64, the rate for nephritis and Bright's disease was 116.1 per 100,000 males in England and Wales, while the figures for Bright's disease alone among British born males living in Pennsylvania and New York were 239.8 and 288.3, respectively. Deaths from accidental violence are also more frequent among the British in America; British born males aged 25–44 show rates of 219.1 and 138.8 per 100,000 in Pennsylvania and New York, in contrast with 59.8 for males of the same ages in England and Wales.

IRISH

Irish immigration into the United States reached its highest point as far back as 1850, the Irish being then 42.8 per cent (by far the largest single component) of the total foreign born in America. In recent decades, the Irish born have, with the Germans and British, declined in relative importance among the foreign stocks. In 1910, they were only 10.0 per cent of the total foreign born in this country. In Pennsylvania in 1910, there were 165,091 Irish born persons, comprising 11.5 per cent of the foreign born white and 2.2 per cent of the total white population. In New York State, the number of persons born in Ireland was 367,877; they formed 13.5 per cent of the total foreign born and 4.1 per cent of the total white population of the state. Table XIV presents death rates of Irish born persons living in Pennsylvania and in New York, by sex and age, 1910:

TABLE XIV

DEATHS PER 1,000 WHITE POPULATION AMONG PERSONS BORN IN IRELAND AND AMONG NATIVE BORN OF NATIVE PARENTAGE, BY SEX AND BY AGE PERIOD. PENNSYLVANIA AND NEW YORK STATE, 1910

Sex and age period	Pennsylvania		New York	
	Native born of native parentage	Irish born	Native born of native parentage	Irish born
MALES				
All ages:				
Crude rate	14.2	40.6	15.9	40.2
Ages 10 and over:				
Crude rate	11.5	40.7	13.8	40.3
Standardized rate	12.8	23.6	13.8	25.9
Under 10	22.6	16.5	23.5	16.8
10–14	2.3	3.0	2.5	....
15–19	3.3	5.7	3.6	8.1
20–24	4.9	8.9	5.0	9.4
25–44	6.2	15.1	6.9	18.5
45–64	16.8	40.4	18.8	46.3
65–84	75.2	103.1	77.3	101.6
85 and over	253.0	301.6	268.9	286.1
FEMALES				
All ages:				
Crude rate	12.7	35.0	13.9	34.8
Ages 10 and over:				
Crude rate	10.9	35.0	12.4	34.9
Standardized rate	12.3	20.5	12.4	23.5
Under 10	18.6	29.2	19.6	10.4
10–14	2.3	....	2.6	4.1
15–19	3.3	2.5	3.2	3.9
20–24	4.2	3.6	4.7	4.1
25–44	5.8	10.2	5.7	12.0
45–64	14.4	35.1	14.3	40.7
65–84	66.6	104.2	68.2	107.4
85 and over	253.8	288.3	242.3	307.6

Table XIV shows that in this country a very high mortality exists among the Irish. Eliminating from consideration all age periods below 20, because of the small representation of the Irish immigrants at the younger ages, the Irish males show death rates very greatly in excess of the native stock; at ages 25 to 64, the rates are over two and one-half times higher. The same situation exists for females beginning with age 25.

Ages 10 and over, taken together, show crude rates of 40.7 and 40.3 for males in Pennsylvania and New York State,

TABLE XV

DEATH RATES OF PERSONS BORN IN IRELAND, FOR THE PRINCIPAL CAUSES OF DEATH, BY SEX AND BY AGE PERIOD, PENNSYLVANIA AND NEW YORK STATE, 1910

Sex and age period	All causes		Tuberculosis of lungs		Cancer		Organic heart diseases		Pneumonia		Bright's disease		Violence excl. suicide	
	Rate per 1,000		Rate per 100,000		Rate per 100,000		Rate per 100,000		Rate per 100,000		Rate per 100,000		Rate per 100,000	
	Pa.	N. Y.	Pa.	N. Y.	Pa.	N. Y.	Pa.	N. Y.	Pa.	N. Y.	Pa.	N. Y.	Pa.	N. Y.
Males														
All ages	40.6	40.2	342.8	589.3	209.2	237.6	557.5	560.9	530.0	451.5	399.2	471.4	357.9	305.9
Under 10 ...	16.5	16.8	....	....	....	....	274.7	140.1	274.7	140.1	....	....	....	140.1
10–14	3.0	....	....	....	....	....	....	....	....	....	....	....	296.7	....
15–19	5.7	8.1	428.0	312.3	....	....	....	....	....	....	....	....	....	124.9
20–24	8.9	9.4	127.7	327.3	....	....	31.9	21.1	63.8	52.8	....	42.2	414.9	253.4
25–44	15.1	18.5	375.8	662.9	53.7	45.2	93.1	90.3	182.5	211.2	85.9	120.9	261.3	278.3
45–64	40.4	46.3	408.8	682.1	208.1	339.1	529.3	580.2	620.5	601.7	419.8	662.5	434.4	321.4
65–84	103.1	101.6	206.1	329.3	651.3	694.7	1706.7	2088.5	1253.2	1024.0	1146.0	1299.1	412.2	406.0
85 and over .	301.6	286.1	....	357.6	232.0	1311.1	5800.5	5601.9	2088.2	1907.0	2552.2	2145.4	928.1	357.6
Unknown...	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Females														
All ages	35.0	34.8	201.2	276.1	269.4	269.0	493.3	600.2	395.9	411.6	387.3	453.0	143.9	95.5
Under 10 ...	29.2	10.4	....	....	....	....	291.5	129.5	583.1	129.5	....	....	291.5	129.5
10–14	....	4.1	....	138.1	....	....	....	....	....	138.1	....	....	....	....
15–19	2.5	3.9	63.6	185.6	....	....	63.6	....	....	....	63.6	....	....	23.2
20–24	3.6	4.1	121.6	167.7	....	....	....	16.8	30.4	22.4	15.2	11.2	....	11.2
25–44	10.2	12.0	235.3	353.4	96.3	82.2	90.9	100.3	90.9	110.0	85.6	117.4	29.4	31.0
45–64	35.1	40.7	220.7	250.1	352.5	432.9	513.9	656.4	448.0	523.6	421.6	636.1	118.5	104.7
65–84	104.2	107.4	140.9	192.1	657.5	684.2	1590.2	2312.1	1187.6	1331.3	1201.0	1388.6	496.5	306.7
85 and over .	288.3	307.6	148.6	....	1040.1	1207.7	4011.8	5797.1	2228.8	2898.6	2526.0	2576.5	1634.5	966.2
Unknown...	....	....	....	....	....	....	....	....	....	....	....	....	....	....

respectively, and 35.0 and 34.9 for females. These, when standardized for age, are reduced to 23.6 and 25.9 for males, and 20.5 and 23.5 for females. The rates are, therefore, nearly twice as high as those of the native stock.

An examination of the causes for these very unfavorable conditions (Table XV) shows, in exaggerated form, a situation not unlike that previously described for the German born population.

With regard to pulmonary tuberculosis, the Irish born are under a great handicap. At ages 25–44, for example, the rate for this cause among Irish males is, in each state, twice as large as for natives; thus, in Pennsylvania, the rate for Irish males is 375.8 per 100,000 compared with 185.2 for native born males, and in New York the corresponding figures are 662.9 and 352.0, respectively. At ages 45–64, the Irish disadvantage is even greater. Among females at the same ages, the disparity is somewhat less marked, although it is still present.

In both sexes at ages 25 to 84, the rates for pneumonia (all forms) are much higher among the Irish born. Irish males, 45–64, present rates of 620.5 and 601.7 in Pennsylvania and New York, while males born in the United States show but 166.0 and 189.6, respectively. Among females at corresponding ages, the situation is similar.

The facts relative to cancer, organic diseases of the heart, and Bright's disease may be summarized as follows: In the age periods 25–44, 45–64, and 65–84, which are the significant ages for these diseases, the Irish born, without exception, show higher specific death rates than the native born. This statement holds for both sexes and in both states. Deaths from violence (excluding suicide) are likewise more numerous among the Irish born.

In their own country, the mortality rates of the Irish present no such untoward conditions as they show in the United States. From ages 15 onward in the last censal year (1911), the rates for males were much lower than for the Irish in Pennsylvania and New York, the advantage at 25 to 64 being over 50 per cent.* For females after age 25 is reached, the situation is much the same as for males. When we compare the rates for the important causes of death after 25, we find that almost without exception the Irish at home enjoy marked advantages. For example, Irish males at home aged 45–64 had, in 1911, a pneumonia rate of 163.2 per 100,000, which is in very marked contrast to the rates of 620.5 and 601.7 for Irish born males in Pennsylvania and in New York. Similarly, the pneumonia rate for Irish females (45–64) is 89.8 in their own country, as against 448.0 and 523.6 in Pennsylvania and New York. Even more striking are the figures for Bright's disease. At 65–84, Irish males at home show a mortality from this cause of but 115.3 per 100,000 as against the very high rates of 1146.0 and 1299.1 for Irish born males living in Pennsylvania and New York. For Irish females in their own country, the rate at 65–84 is only 63.8 per 100,000, an amazing contrast to 1201.0 and 1388.6 for Irish born of the same age in this country.* The mortality from organic heart disease at ages 65–84 is twice as high among the Irish living in America.

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* Forty-eighth (1911) and Forty-ninth (1912) Annual Reports of the Registrar-General for Ireland, pp. 150, 120–129.

The foregoing figures for German, British, and Irish immigrants help to explain some of the features we noticed in our discussion of the general death rates in Table II. It will be remembered that at ages 25–44, the native born males of foreign or mixed parentage, that is, first generation Americans, showed in Pennsylvania a death rate of 12.3 per thousand, while the mortality of the foreign born was only 9.1; and in New York State, their rate was 14.3 per 1,000 as contrasted to 8.7 for the foreign born. At the next two age periods, the rates for these two classes of the foreign stock were very similar, and the native stock was at a great advantage.

We are now able to state the probable reasons for this peculiar relationship. In the age period 25–44, the predominating stocks which make up the native born of foreign parentage are the Germans, British, and Irish, whose death rates we have found are high. The foreign born group at the same age period, on the other hand, has large proportions of Italians, Russian Jews, and Austro-Hungarians. It is the low mortality of these races which, at ages 25–44, offsets the very unfavorable conditions among the Germans, British, and Irish elements of the foreign born, and gives a net rate lower than that for the native born of foreign or mixed parentage, which contains no such reducing factor. But here this influence stops. The foreign born at 45–64 and 65–84 are predominantly Germans, British, and Irish; we see that their rates are almost identical with those for the native born of foreign or mixed parentage, composed, at these ages, of similar stock. The same reasoning applies to females. Here, the smaller excess of the first generation Americans over the foreign born at 25–44 is due to the fact that the rates of the two contrasting groups of the foreign born are more nearly equal than is the case among males.

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* The death rates for Bright's disease in Ireland are so remarkably low as to suggest some differences in classification procedure as a factor.

We have examined each of the important nationality groups in the white population and have considered under each group the causes of death which characterize the mortality. It will now be profitable to reverse the viewpoint, summarizing briefly for each important cause of death the facts as to the various groups in the foreign born populations of Pennsylvania and New York. The causes of death will be considered in the order in which they stand in the International List of Causes of Death.

Tuberculosis of Lungs (*28, 29**).—The outstanding feature relative to pulmonary tuberculosis is the very unfavorable position of the Irish. Both sexes suffer extraordinarily from this disease during the greater part of life (25 to 84). At 25–44, the rates for Irish males are twice as high as for natives, and in the age period 45–64 the excess is even greater. The death rate among Irish males from tuberculosis continues high even at the advanced ages. The facts with regard to the Irish in the two states studied, are very different indeed from those in the native country, both as to the high rates obtained and the general configuration of the mortality curve. German and British males also show higher tuberculosis rates than the native born at the older ages. On the other hand, the Italians, Russians, and Austro-Hungarians present comparatively low tuberculosis death rates. At most of the age periods they are even lower than for the native born. Italian females in New York show a striking exception to the usual rule in that their rates are higher than those for males, especially in early life. Otherwise, there are no important differences in the several race groups with reference to this disease.

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* International List of Causes of Death, 2nd Decennial Revision, 1909.

Cancer (*39–45*).—Practically every foreign race group shows higher cancer rates than do the native born. Italian males and females offer the only clear-cut exceptions. At the age period 45 to 64, foreign born males show rates from 50 to 100 per cent higher. The conditions among the Irish are strikingly bad. Among females at ages 45–64, the Germans and the British also show higher rates than do the native born, but the excess is not as marked as it is among the Irish.

Organic Diseases of the Heart (*79*).—Again the Irish present the highest rates, followed by the British and the Germans. The conditions prevailing among those from Austria-Hungary, Russia, and Italy are, on the whole, very favorable with regard to this disease. It is very difficult to understand the reason for the aberrant death rates among the Irish in Pennsylvania and New York, for they are so much higher than are those for the native stock and for the Irish in their own country.

Pneumonia (*all forms*) (*91, 92*).—From ages 45 to 84, the rates of the native born are much the lowest. The Irish are again under the greatest handicap, their rates being about three times as high at ages 45–64. The rates for Italians are very unfavorable also at ages 45 to 84. The disadvantage of the Germans, British, and Russians is less among females than among males. The position of the Austro-Hungarians is very much the same as the native born at 25 to 64.

Bright's disease (*120*).—Again, we must record the very unfavorable position which the Irish occupy. From 25 to 84 years of age, the rates for this nationality are about 100 per cent. higher than for the native born; among females, the excess is even greater. At ages 45 to 84, the rates from Bright's disease are high for Austro-Hungarians, Russians, Germans, and British. The position of the Italians is quite favorable.

Violence (*excluding suicide*) (*164–186*).—Deaths from this cause are largely from accident, and we find, of course, that the positions of the several race groups are determined by the extent to which they engage in occupations that expose them to such dangers. The figures are especially striking for Pennsylvania where large numbers of immigrants find employment in mills and mines. Males of all the important foreign groups show very high rates from this cause, the worst conditions prevailing among the Austro-Hungarians, followed by the Irish and the Italians.

SUMMARY

1. Of the three main groups of the white population in Pennsylvania and in New York, (a) native born of native parents, (b) native born of foreign or mixed parentage, and (c) foreign born, the first has the lowest mortality. This is true for both sexes and for virtually every age period, but is most marked at the adult ages.

2. The foreign born, and the native born of foreign or mixed parentage, agree much more closely with each other than with the native stock. An interesting exception presents itself, however, at ages 25–44, at which period the foreign born have a great advantage over the native born of foreign or mixed parentage. The reason for this is the predominance of the Irish, German, and British stocks among the first generation Americans at this age period. After age 45, these two groups of the foreign stock are of the same racial extraction, and their death rates are in very close agreement.

3. The death rates of the component groups among the foreign born vary considerably. The Austro-Hungarians, Russians, and Italians present altogether favorable conditions, while the British, Germans, and Irish show death rates very greatly in excess. This is especially true of the Irish, whose mortality is about double that of the native stock. The rates for the Germans, British, and Irish are much higher in America than in their own countries. Pulmonary tuberculosis, pneumonia and the degenerative diseases including heart disease, Bright's disease, and cancer are largely responsible for this unfavorable mortality.

4. The findings of the previous study for New York State are confirmed. The unfavorable conditions of life and work among foreign races to which attention was directed in the

study for New York are found to prevail in Pennsylvania as well. The facts emphasize the necessity for special public health work for the people of foreign origin. The much more favorable economic conditions under which they live in the United States than in their own countries should result in lower death rates. But in several instances, we found that this does not prevail; the facts indicate, on the whole, deterioration rather than improvement. Is it possible that our immigrants are not representative of the best in their native countries? It has often been supposed that the immigrants comprised the most vigorous among their own people; the results, however, do not confirm this impression, but suggest many questions for further inquiry.

5. It is very important that a study similar to this one be carried out as soon as the results of the 1920 census are available, to determine whether any differences of importance have appeared in the interval of ten years.

STATISTICAL STANDARDS IN BUSINESS RESEARCH

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I. INTRODUCTION

The great war furnished the occasion, if not the motive, for business and economic prescience. It served to dignify facts and to direct the uses to which they were put. Largely due to the war, the case for business and economic planning has been won and the function of fact analysis in business has been demonstrated. The excuse for the organization and the point of view which the war developed are no longer present, but the need remains. Somehow or other, the gains secured to business, industrial, and economic research must be preserved, and the scope of research must be broadened and the method improved. A sufficient sanction for the accomplishment of these ends must be discovered and applied.

Industry has adopted a new point of view. Laboratories for experimentation are now found in the largest industrial establishments. Research under some auspices is being extended to the physical and chemical fields; to purchasing and selling methods; to production time- and motion-study; to behavioristic psychology and employment management; to market breadth, depth, and elasticity; to phenomena of prices and costs, and to the factors by which market fluctuations may be anticipated and uncertainties discounted. Hardly a week passes without the establishment within some business of so-called research departments, or the organization of private agencies for research purposes. Problems of personnel, marketing, costs, industrial relations are all being subjected to some sort of analysis. How scientifically this work is being undertaken, how completely the motive and methods are influenced by considerations of profits, it would be impossible to determine without an analysis of each unit. Such an analysis, although it may be needed, cannot be made here. The purpose of this paper is less comprehensive and, it is believed, more important at the present time. It is to formulate in brief compass some of the more fundamental statistical standards of business research, and to suggest the content of scientific method when applied to the study of business problems. It is not to enumerate a series of rules of procedure covering the different stages in statistical analysis. To do this would be to repeat what has been written elsewhere. The broader task is attempted with the hope of contributing something to the technique of scientific method when applied in business research.

The method of treatment is *first*, to state the case for research in business fields; *second*, briefly to explain the research point of view and method, with special application to business problems; *third*, to formulate the standards to which research must conform throughout the different steps in statistical analysis. This is done by considering (a) standards for business facts, (b) standards for collection or summation, (c) standards for classification and tabulation, (d) standards for graphic representation, (e) standards for interpretation, (f) standards of organizations for research purposes when research is undertaken as a regular part of university work.

II. SCIENTIFIC METHOD AND BUSINESS RESEARCH

Research involves both a point of view and a method. The point of view is an unconditional demand for the truth; the method is (1) intelligent observation, (2) scientific measurement, (3) impartial analysis, (4) logical inference, and (5) sincere application of the conclusions reached to the problems to which the facts and observations apply.

Scientific method has been defined as a state of mind, and this is probably a true characterization if the qualification is added that the point of view which it represents is consistent in seeking the truth, and in being guided by facts, not at one time, in one place, or under one condition, ignoring them when it becomes advantageous or when they are difficult to determine, but in all places, at all times, and under all conditions. To the fact analyst, imbued with the spirit of scientific method, facts are facts. They are welcomed for the truth which they contain. The attitude toward them and toward the changes which they make imperative, or the beliefs or customs which they challenge, is positive, receptive, and open-minded; not negative, doubtful, and hesitant. It is not a little truth, but the whole truth, which is desired. The essence of science is not so much in its content or in its product as it is in its method.

Research implies a laboratory from which facts may be secured or in which they may be developed. Because of the frame of mind which the war developed and nurtured, business today, in many respects, constitutes an ideal laboratory. Merely as the result of daily operations, great masses of comparable facts which may be statistically expressed are currently developed. Some of these are crude, it is true,—they are "in the rough." This is especially so in small businesses where accounting principles are neglected or ignored, or where competition, state control, or public necessity has not required comparable records to be kept. In the larger industries, however, where markets are wide and competition severe, and where large-scale production, utilization of waste, and the creation of by-products is the rule, the facts are far more nearly satisfactory. Not for all purposes, of course, for no business fact, however carefully prepared, is equally good for all purposes. Definition, measurement, and use are interrelated; they cannot be divorced from one another. The field for business research is ready or in preparation; the sanction for research is daily being extended to private and public agencies. This sanction must neither be abused nor destroyed.

There are two approaches to business analysis or research which, for convenience, may be described as the *inside approach with an outside perspective*, and the *outside approach with an inside significance.* The discovery of business principles, the measurement of business success, the anticipation of business difficulties, and the elimination or adjustment of business risks and friction are the ends sought in both approaches. The methods employed and the facts considered are different, more in their scope than in their essential nature.

Research addressed to *inside facts with an outside perspective* extends to costs, sales, markets, credits, production methods and control, personnel, wages, and conditions of employment. Its purpose is to eliminate waste of materials, money, and effort; to increase production and sales, and to decrease costs. Its end is narrowly pecuniary; the motive which prompts it, acquisitive; and its results are generally of restricted consumption. The increase of profits is its *raison d'être.*

Research addressed to *outside facts with an inside significance* proceeds differently. Individual experiences are lost in the totality of experiences as they are shown in *trends* of production, earnings, costs, prices, credit, wages, population growth, concentration, etc. The aim is not so much to secure an immediate increase of profits as it is to measure or to anticipate demand, to forecast change, to bridge the gulf between the present and the future, and to measure and to correlate the economic and social forces which determine business growth and decline. The long-time viewpoint and the study of fundamental causes and effects are the controlling factors. Obviously, the results of this type of research, if it accomplishes its end and its results are utilized, may be as narrowly pecuniary as the results of the other. The facts observed are much the same, but the approach is different. The methods followed, in so far as they are scientific, are identical. Scientific method knows no variation; it does not find its justification in the salability of its product.

These two phases of business research are complementary. For those who are studying business from the outside to lose sight of the inside facts is unscientific; for those who are studying the inside facts to fail to appreciate their outside significance is without justification. "Inside" and "outside" are simply different points of view. Acquisitively, the inside perspective seems to be more important; socially, the outside looms the larger.

III. BUSINESS FACTS—STANDARDS TO WHICH THEY MUST CONFORM

The measurements of business facts, statistical or otherwise, are always relative; they require the use of both a unit and a standard of measurement. Standardization in measurement implies homogeneity; it suggests conformity and suitability to conditions determined in the light of particular application. Measurement involves not only an application of a unit of measurement, but also an interpretation of the results obtained from the application. Things which are equal to each other in name are often not so in use or in meaning. The meaning of a measurement of a business fact is a function of the use to which the measurement is put. The point which is being made is that the meaning, use, and measurement of business facts cannot be dissociated. Scientific method requires that business problems be broken up into their various parts, that they be measured by standardized units, and that comparisons between them rest upon common qualities.

As a basis for the application of scientific method to business problems, statistical units must, *first,* be homogeneous. Characteristics that are significant for the purpose for which facts are to be used, must not be ignored. It is, of course, impossible to secure perfect homogeneity. It is not impossible, however, to classify differences according to the significance that these have for particular uses. After all, homogeneity is simply relative. Differences that are significant from one point of view may be ignored from others. Statistical methods require that facts, as well as the differences that characterize them, shall be classified, and that the bases of classification for both shall be chosen according to the significance which they have for particular uses.

Second. Statistical facts must be *representative.* Facts that, because of the ignorance or design of those who collect or use them, do not meet this condition, are an uncertain base upon which to formulate business judgments. Where bias rules, occasions for error exist. It is immaterial whether bias results from wilful elimination of a part of the facts, from basing conclusions on insufficient or unrepresentive data, or from comparing periods and conditions that have nothing in common. When business problems are approached scientifically, truth is desired and every effort must be made to secure it. It is the function of facts to reveal the truth, not to conceal and distort it.

Third. Facts must *fit;* they must be germane. Here, the consideration is not primarily of measurement, but rather of interpretation. Ignorantly or wilfully to select facts at random and without definite purpose in order to support a contention, or to excuse or develop a business policy, violates every phase of scientific method. Both intelligent observation and logical inference are sacrificed. The fundamental principle which requires that every fact be referred to the condition which can produce it, is violated.

Fourth. Facts must be *stable.* They must relate to purposes and conditions that are essentially uniform. While absolute uniformity is unthinkable, essential uniformity is possible of realization. Business judgments based on exceptional or erratic observations, conditions, or periods, are unstable. It is necessary to distinguish between short- and long-time influences, between exceptional and normal relationships, between periods of decline and periods of growth, between cyclic and secular trends, between transitory phases and permanent tendencies. Business facts and relationships are constantly changing. In some, fluctuations are rapid; in others, infrequent. In some, they are sporadic; in others, they are periodic. The measurement and interpretation of facts must be adjusted to time, place, and condition.

Fifth. Both the facts themselves and the conditions of measurement must be *comparable.* Like can only be compared with like. Shifting conditions of measurement and changing units cannot be tolerated. The measuring stick and the method of applying it must be uniform for all measurements.

Sixth. Facts must be *accurate.* Accuracy is affected by the conditions under which facts are reported and collected, by the unit which is used, and the method by which it is employed. Absolute accuracy in most lines of research is unthinkable; essential accuracy is generally realizable. Business facts, like others, are generally variates, the measurements serving merely as sufficient approximations to an ideal. In the matter of price changes, Dr. Mitchell has forcibly called attention to this fact.

Statistical standards of accuracy allow for the corrective elements of chance and give free play for the operation of the "law of averages." Biased errors of unknown amounts and direction are disturbing, but unbiased errors, subject to chance distribution, are of little significance when problems are studied in the aggregate or as totals. But to expect errors always to be compensating, and truth always to emerge from a tissue of falsehood is to be too sanguine. "The other things" which one so confidently hopes will remain "equal," rarely so behave for business phenomena. That caution which urges one to stay close to the original data, verifying truths and correcting errors, is no less applicable to statistical than it is to any other form of research.

Such are the statistical standards to which business facts must conform. The degree to which they have been realized in statistical facts will determine the standards of collection, analysis, and interpretation to which they may be subjected.

IV. STATISTICAL STANDARDS IN THE COLLECTION OF BUSINESS FACTS

Business facts constitute the raw material for business research. They are developed in the routine processes of sales, production, employment, accounting control, and administration. Business relationships, policies, and principles are founded upon them. How may they be secured for research purposes? What are the standards which should govern their collection or summation?

First. Business facts must be collected for a definite purpose. Statistical analysis cannot proceed as if it were in a vacuum; the meaning of a statistical fact is dependent upon the use to which it is put, and the costs of collection are justified only in the realization of a purpose. For collection to proceed without a definite goal in mind is not only wasteful of time and money, but fatal to the idea of research. Facts are not equally good for all purposes. The acts of measurement and of classification presuppose a purpose. To ignore this truth is to proceed unscientifically. Fruitless investigations, carried on at enormous costs and resulting in ill-will on the part of those who are interested in the results, discouragement on the part of those who are undertaking them, and a tendency to scout the idea of research and the function of experts, are largely if not solely traceable to a violation of this seemingly self-evident truth.

Second. Business facts must be collected in standardized units and under uniform methods of application.

Third. A sufficient sanction for the collection or use of data must be secured. To formulate a definite purpose for which facts are desired is the first condition for securing this. It is generally, but not always, necessary to demonstrate that personal advantage will result from a study of the facts furnished. But more than this narrow appeal may be made. Research for its own sake, or in cases in which the results are not capable of immediate capitalization, now appeals to business interest. There is a remarkable tendency for interest to center in a study of principles. "The study of fundamentals" is a business watchword today. Sanction may be secured through coöperation. Research may be made not only *of* business but *with* business. Sanction may be secured not only by granting that facts will be made available for use, but also by insisting that a representative body of the industry or interest studied shall be appointed with which the research organization may and should constantly consult.

Fourth. Standards of collection require that the full import of such questions as the following shall be considered: (1) For what periods, under what conditions, and for what places are the facts available? Are the purposes and methods of research conditioned by the answers secured? (2) Will *available* facts be given, or may they be assembled; and if so, in what units, with what degree of accuracy, and with what effect? (3) Do the schedules or forms used in collection provide for keeping confidential the data supplied? (4) Are the units of measurement which are employed standardized and understood? Do they follow or run counterwise to the terminology of the records employed? How may necessary adjustments be made, and with what effect?

Fifth. Statistical standards require that wherever possible the truth or error of business facts shall be verified. Against the imputation of gullibility, those in charge of research should always be capable of defending themselves. To take on faith the plausible, or to discard seeming exceptions, is not in keeping with scientific method. Verification requires more than testing mechanical accuracy and removing apparent inconsistencies. It involves an analysis of the composition of groups and totals, and a scrutiny of the uniformity of measurement and the methods in which units are applied for different times, places, and conditions.

Sixth. The field from which data are secured must be adequate and the facts inclusive or representative. The choice of the field and the selection of the facts depend upon the purpose for which research is undertaken. A problem requiring inclusive data must be approached differently from one which may be studied by means of samples. Standards of collection may, indeed, become standards of elimination; and balance and consistency, rather than merely the verification of accuracy, may become the goal.

V. STATISTICAL STANDARDS IN TABULATING BUSINESS FACTS

Tabulation is a means, *first,* of recording in fixed form a classification previously developed, or, *second,* of placing similar facts in juxtaposition or in groups as a preliminary to a final classification. It is a device for projecting on a surface, capable of being read in two dimensions, a classification which has been worked out, or is being worked out. It is a method of recording a process of thought. It is inelastic in structure; the facts which it contains are in truth "locked up." Classification precedes; tabulation follows. The sequence of thought is from purpose to method.

The statistical standards to which tabulation must conform are as follows, and here again it is necessary to repeat that it is not the purpose of this paper to formulate a set of rules governing the make-up of tabulation forms, but rather to develop the statistical standards in tabulation which lie back of the rules, the realization of which may require a variable technique.

First. Every tabulation surface should faithfully record the classification which it is intended to depict. The purpose of tabulation and the standard to which it must conform cannot be divorced.

Second. There is always a *best* form of tabulation for a given purpose, as there is a most logical basis of classification. Indiscriminate choice of forms is as much without justification as is a meaningless or superficial classification.

Third. Every tabulation should be adjusted in form and complexity (a) to the subject matter which is to be expressed, and (b) to the person for whom it is prepared, or to the end to which it is addressed.

Fourth. The order of detail in tabulation forms should be adjusted so as to be emphatic. It should be natural, not artificial; convincing, not purposeless.

Fifth. Statistical tables should carry only relevant data. The reciprocal relation between relevancy of fact and the purpose to be accomplished by tabulation, is the thought which is stressed.

Sixth. Statistical tables should carry on their face both their justification and their explanation.

Seventh. The details of statistical tables should be mechanically accurate, and their grouping and arrangement consistent, logical, and serviceable.

Eighth. The natural order in classification is from detail to summary; the serviceable order in tabulation is from summary to detail.

Ninth. Brevity is said to be "the soul of wit." It is equally true that conciseness in tabulation is the secret of its effectiveness for business purposes.

VI. STATISTICAL STANDARDS IN THE GRAPHIC PRESENTATION OF BUSINESS FACTS

The excuse for the use of graphics in business research is largely if not wholly their universal appeal. Graphs speak a common but frequently an inarticulate and confused language. There is an attractiveness about them which is alluring but often deceptive. Their appeal is visual and instantaneous, not necessarily reasoned and reflective.

Again distinguishing between rules for graphic presentation and the standards which give pertinency to the rules, the following standards may be formulated:

First. A statistical fact and its form of representation should agree. By this single standard, deception, whether resulting from a confusion of the apparent with the real, or of the superficial with the fundamental, is fully provided against. The object of business research, as it is in all research, is the establishment or determination of truth. Standards for graphics provide for their use in influencing but never in deceiving men. In spite of the standards adhered to, however, both results may be accomplished by the same graphic device. "It is their appeal, their smug finality, which suggests their virtues and at the same time conceals their weaknesses."

Second. Graphic forms should be selected according to their psychological appeal and their ease of comprehension, care always being taken not to violate the first standard.

Third. Graphic forms should be chosen in accordance with (a) the form and complexity of the subject matter illustrated, and (b) the type of consumer for whom they are intended, or the purpose which they are designed to serve.

Fourth. Graphic devices should be considered more as illustrations of analysis than methods by which analysis is made.

Fifth. Graphic figures should be drawn as accurately as a visual representation will permit. Accuracy, of course, is never absolute. In graphics, the realization of relative accuracy of each part and of the totality is the standard set. To this standard, a corollary is needed; graphic forms should always be accompanied by the original data which they represent.

VII. STATISTICAL STANDARDS IN THE INTERPRETATION OF BUSINESS FACTS

All forms of research involve an application of the scientific method. But business research offers peculiar difficulties. In far too many cases, it is undertaken for profit and influenced by conditions of profit. It is seriously undertaken today and overthrown tomorrow; adopted in one line of endeavor and scouted in another. It is undertaken by fits and starts, first welcomed and then dismissed. The results are too frequently given a narrow interpretation and are restricted to purely inside affairs without an appreciation of their intimate relations to outside facts. Business and industry are too often considered as made up of independent units, or as involving separate problems, sections or individual aspects of which may be studied separately, and the facts concerning them independently interpreted. For instance, those engaged in research in time- and motion-studies have only lately, if at all, come to appreciate the fact that men, not automatons, are under the microscope.

Business is complex and so must be the interpretation which is given to business facts. To look for a single meaning in, and to expect a single consequence to follow from, a group of business facts is to be grossly unscientific.

Given a related group of business facts which have been collected, tabulated, and graphically expressed according to the conditions that have been formulated, to what standards must an interpretation of them conform? To fail to attach meaning and significance to them as bases for business policy and foresight, is merely to accentuate the all too prevailing practice of leaving untranslated into business standards and principles the myriads of facts daily growing out of, or experienced in, business relations.

Some of the fundamental standards of interpretation are as follows:

First. The truth is the end sought; error is not to be disguised, falsehood tolerated, or preconceptions favored.

Second. Comparisons can be made only between things, conditions, times, and places having common qualities.

Third. In interpretation, facts must always be referred to conditions which can produce them.

Fourth. Interpretation should extend to an explanation of the past and a forecast of the future. For business purposes, facts are more significant as bases for planning future policy than for explaining or justifying past action.

Fifth. Distinction should be made between long- and short-time conditions and consequences; between transitory skirmishes and general tendencies.

Sixth. Avoid the error of confusing the results of a single cause with the results of a combination of causes; of identifying proximate and remote causes; and of expecting a single cause always to give rise to a single effect. A given cause is not an homogeneous thing except when viewed in the broadest way. The effects which seem to follow from it do not come as an undifferentiated whole, but as variations. Some come as coincidences; others, as sequences spread over long or short periods. Both cause and effect are in reality variates.

Seventh. Distinction should be made between drawing a particular deduction and giving it general application.

Eighth. Similarities and differences should be appraised in the light of particular application. Similarities that are complete for one purpose are incomplete for others; and differences that are fundamental for one purpose often may be ignored for others.

Ninth. The detail of interpretation should conform to the nature of the problem and to the capacity of those interested. Not infrequently an exaggerated accuracy, which the nature of the basic data does not justify, or the occasion for summarizing warrant, is worked out in meticulous detail by means of percentages, averages, and other summary expressions. Similarly, far-reaching conclusions are sometimes drawn from inadequate data by elaborate and over-refined methods. Statistical analysis then appears as an inverted and unstable pyramid.

Likewise, involved and complex interpretations are sometimes prepared for those who are statistically ignorant of refined processes, or for those who are disinclined to follow or are uninterested in pursuing an elaborate analysis. A statistical interpretation designed to influence executive action or to enlist administrative support is rarely, if ever, to be couched in the same language or to include the same detail as one which is intended to serve the simple purpose of record. Consumers of statistics differ not only in their statistical interests but also in their statistical horizons.

VIII. ORGANIZATION FOR BUSINESS RESEARCH

The goal set by research organizations in the study of business facts and practices should be to realize for each of the steps in analysis, the standards which have been enumerated. No one form of organization is best suited to accomplish this for all purposes. The relation of purpose and method is as significant in this respect as it is for the other aspects of research. A simple analysis, extending only to the surface phases of business problems, may be made by loosely formed and unscientifically disposed organizations. On the other hand, a comprehensive analysis, extending to the deeper significance of business facts and practices, requires a correspondingly elaborate and scientifically inclined organization. The one indispensable condition that must always be met is that imposed by the standards of the scientific point of view. The requirements of this standard are of universal application; the way in which they are to be realized varies in each organization according to the scope of the problems that are studied and the required technique.

STANDARDIZATION OF THE CONSTRUCTION OF STATISTICAL TABLES

By Edmund E. Day, *Harvard University*

The progress of every art should be marked by the accumulation of an increasing stock of generally accepted practices. As these practices obtain common approval, they should be recognized as standard and regularly followed until more satisfactory methods are discovered. A measure of standardization is thus a normal feature of development.

Standardization nevertheless has its dangers. Like "law and order" in civil life, it may be overdone. There is always the risk of formalism. But kept within proper limits, standardization has a steadying influence which tends to accelerate, not retard, the advancement of the art. It effects good order, and is an unmistakable mark of real progress. It is consequently profitable to consider from time to time the extent to which standardization can advantageously be accepted. In statistical exposition, the standardization of graphic methods has been one of the gratifying advances of recent years. To what extent has there been and to what extent are there further opportunities for a similar standardization of practice in the methods of tabular presentation?

In considering this question, it should not be thought that standardization is accomplished only through the conscious adoption of rules and regulations set up by recognized organs of authority. Standardized statistical practices may evolve by imperceptible degrees through the influences of imitation and prestige. This is particularly the case if some one statistical bureau is the fountain-head of governmental practice. The working rules of such an office tend to become the rules of a following of less influential practitioners. Standardization of this kind is going on at all times. Such standardization of practice as we have today in statistical work in this country is almost altogether the result of these influences of imitation and prestige.

Unconscious standardization of this sort has already made substantial progress with regard to the structure of statistical tables. Without attempting a complete enumeration of the rules observed by competent authorities, a few of the standard practices may be noted in passing. It is generally recognized: (1) that every table should be self-sufficing, containing within itself a clear explanation of the meaning of the items displayed; (2) that every table should be logically a unit, containing only data which are intimately related with one another; (3) that column- and row-headings should be brief, unambiguous, and self-explanatory, table footnotes being used when necessary to make the headings perfectly clear; (4) that coördinate and subordinate relationships among the column- and row-headings should be shown by variations of boxing in the captions and of indentation in the stub; (5) that varieties of letters, figures, lines, column-widths, and interlinear spacings should be employed to facilitate easy and intelligent use of the table; (6) that columns and rows should be lettered or numbered if cross reference is desirable; and (7) that sources and units should invariably be indicated. The common acceptance of these principles represents no mean advance in the standardization of statistical table structure.

It is to be observed, however, that the standardization thus far effected concerns primarily the constituent parts of the table, not the table's general form. The choice of position between columns and rows, the arrangement of the several columns or the several rows, and the location of particular columns toward the left of the table or of particular rows toward the top, seem still to be matters of individual preference, if not of chance. It is important to consider how far standardization of the general form of statistical tables is feasible and desirable.

Standardization of the general form of statistical tables must begin with a distinction between general-purpose and special-purpose tables. The general-purpose table is designed to bring together in most convenient and accessible form all the data bearing upon a given topic. The special-purpose table is intended to throw into relief relationships of special significance in a given study. The general-purpose table is an orderly presentation of statistical material; the special-purpose table, a record of the results of statistical analysis. Of course, a measure of analysis is a prerequisite even of the general-purpose table, but the analysis is of a different order. It is the analysis essential to effective enumeration and tabulation, not the analysis accompanying specific interpretation. The analysis required for the special-purpose table is directed toward a particular issue. The problems of good table structure are essentially different for the two types of tables.

Since the construction of the general-purpose table is the simpler case, it will be examined first. In considerable measure, the general-purpose, or primary, table is a creature of the physical form of the medium in which it appears. Upon the one hand, the table tends to expand to accommodate the large body of data pressing for inclusion. Upon the other hand, the capacity of the printed page—even if it be folio—stands as a limit on the indefinite enlargement of the table. Tables which are allowed to exceed the dimensions of the page and have to be folded in are everywhere recognized as objectionable. Loose tables, separately printed in large irregular sizes, are as bad, if not worse. Tables running across two pages facing one another are reasonably satisfactory, but are to be avoided where possible. Tables which are presented at right angles to the text fall into the same class. In general, the single page, held as when reading the text, is the maximum size to which the statistical table should be permitted to run. Primary tables usually press upon this physical limit; their outside dimensions are thus independently determined.

Within the table, similar influences are at work. Whether given arrays of data shall be exhibited in columns or in rows is commonly a question of the difference in the vertical and horizontal capacity of the page. The maximum number of lines in a table is several times greater than the maximum number of columns. Consequently the arrays having the greatest number of items are naturally assigned to the columns, the other arrays to the rows. Once a given set of headings has appeared in caption- or stub-position, there is a strong presumption in favor of its occupying the same position in other related tables, for the transcription of data from general tables is thereby facilitated. Upon the whole, however, the assignment of columns and rows rests fundamentally upon the greater capacity of the column—a factor not subject to modification by the statistician.

A much larger measure of option may be exercised in fixing, in a general-purpose table, the order of columns and of rows. Almost any systematic plan may be adopted; but the most satisfactory arrangements are the alphabetical, chronological, geographical, or according to the magnitude of the items. There are no grounds for urging the adoption of any one or two of these arrangements to the exclusion of the others. Now one best serves; now another. One rule, however, should govern the final selection in all cases: that order should be employed which keeps the details of the table most generally accessible. Readers will come to the table with a variety of interests. They should be given that table from which in general they can most easily draw the information they seek. Arrangement according to magnitude or importance of items is less satisfactory in general-purpose, than in special-purpose tables, because it depends upon analysis from a single point of view and it is frequently unwise to commit the table to this particular viewpoint. The other arrangements better meet the variety of needs which a primary table is designed to serve. The important end is to secure some logically and commonly understood arrangement which opens the table to easy transcription.

When geographical or chronological orders are adopted, a decision has to be reached as to what items to place at the top and left, and what items at the bottom and right. In the tabular arrangement of the states of this country, the grouping and order followed by the Bureau of the Census may be recognized as standard; the northern New England states stand at the head of the list, the southern Pacific states at the foot. In general, the best statistical practice for this country would seem to be to run geographical series from north to south and from east to west. With chronological series the case is not so clear. Upon the whole, however, for general-purpose tables, the Census Bureau practice of placing most recent dates at the top and left seems commendable if there is a fair presumption that the figures of most recent date will be most frequently transcribed. When, however, the data probably will be transcribed in entirety as time series, it would seem preferable to place the figures for earlier dates toward the top and left. The rule to apply in all these cases is simple: the most generally useful data should be located toward the top and left where accurate transcription is rendered easier by close proximity to the column- and row-headings.

The general or primary table exhibits no specific analysis. Its form is in considerable measure the resultant of the physical limitations of the page and the necessity of presenting a maximum body of data in a way that will make the most generally useful parts most readily accessible. The derived or analytical table is a different statistical device. A derived table is essentially deficient if it fails to exhibit a carefully formulated analysis. It should be constructed to assist a specific interpretation. Every effort should be made to make the table simple. It should contain only those items valuable to the analysis, arranged so as to encourage the deductions the reader is expected to draw. If any line is to be traced between statistical tabulation and statistical analysis, the primary table displays the results of tabulation, the derived table the results of analysis.

Despite this fundamental distinction between primary and derived tables, it is to be admitted in the first place that the derived table is not altogether free from the influences of format which play so important a part in shaping the primary table. For example, if the number of subdivisions in one classification of an analysis is much greater than in the other, it may be necessary to put the more extended classification in the stub merely because stub-capacity is normally so much greater than caption-capacity. Similarly, if the designations in one classification are much longer than in the other, it may be necessary to place the classification with longer headings in the stub, since neither of the alternatives—printing the longer headings vertically at the top of the columns, or widening the columns to accommodate the longer headings horizontally—is at all satisfactory. Such crass considerations as these are at times decisive in determining the structure even of the derived table. But they play a much less inportant part with the derived table than with the primary table. As a rule, the statistician is able to make the general form of the derived table serve the exposition in hand.

One of the most fundamental questions of structure is the assignment of data to columns in some instances, to rows in others. This matter should be settled in the derived table with reference to what comparisons it is most important to present. Comparison of like items in a column is much easier than of like items in a row. It is believed that recognition of this fact will commonly throw chronological, geographical, and quantitative classifications into the stub, and qualitative classifications into the caption; but this is not a necessary outcome. The important principle is to use the column position to promote the more significant comparison.

Arrangement of the several columns and of the several rows in the derived table will be determined by the particular character of the analysis in connection with which the table is employed. If the analysis is of a temporal distribution, a chronological order will be adopted; if of a spacial distribution, a geographical order. If the items are component parts of an aggregate, arrangement will be either according to the relative magnitude or importance of the item, or according to some other order generally recognized in the analysis of the data in question. Presumably the alphabetical arrangement will seldom be followed, since it does not directly disclose significant relationships. Ordinarily the purpose of the analysis will indicate clearly enough the order in which the columns or the rows should be placed.

Naturally, the arrangement of columns and rows should give proper regard to the fact that the most conspicuous position in a statistical table is at the top and left. While it is generally true that derived tables are designed to bring out relationships rather than individual items and that these relationships are properties of the table as a whole rather than of particular parts, it may be desirable in some tables to focus attention especially upon certain more important items. When other considerations will permit, these more important items should be placed in the most exposed positions of the table: namely, at the top and left next to the captions and stub. This rule is a sufficient warrant for placing totals at the top and left when they are clearly the most significant items of the tabulation, and when placing them at the top and left will not give serious offense to the users of the table. If either of these conditions is not present, it would seem preferable to place totals in the positions in which most readers expect to find them, namely, at the bottom and right. There appears to be no adequate reason for departing from the established practice of reading time from top to bottom and left to right. In derived tables, figures for later dates should appear toward the bottom and right. It is the relation between items, not the individual item, which is significant in time series. For many reasons we are accustomed to think of the upper or left-hand of two figures as the earlier, and we draw our conclusions accordingly. Furthermore, this rule is already thoroughly incorporated in our graphic practices. To have diametrically different rules for graphic and tabular presentation would be unfortunate. The Census Bureau practice of placing data for most recent dates at the top and left is therefore not to be approved for the derived table. Effective exposition of the statistical evidences is better served by the order which seems most natural to the great majority of readers. Arrangements of columns and rows should hold fast to the purpose of facilitating interpretation.

If the dominant purpose of the derived table be kept in mind, many problems of tabular arrangement will be readily solved. Percentage distributions will be placed next to the corresponding absolute figures or in a separate portion of the table, according to the emphasis of the analysis. To facilitate comparisons of relationship, the arrangements adopted in one table of an analysis will be followed as closely in the other tables as other more important considerations will permit. Columns and rows which are to be compared with one another will be brought as closely together as possible. Unnecessary digits will be dropped and items given in round numbers to simplify the presentation. The aim throughout will be to make the derived table an effective instrument of statistical exposition.

If such are the considerations involved in the construction of statistical tables, what conclusions are to be drawn regarding the possibilities of standardization of table structure? Upon the whole, the opportunities for complete standardization seem slight except with regard to the elements from which the table is to be constructed, and certain lesser matters of general arrangement. More is to be gained at this time from a clear recognition of important guiding principles in table construction. Careful attention must be paid to the difference of purpose in primary and derived tables. The primary table must be made to offer its items for easy transcription; the derived table, for ready deduction. If statistical tables are formed with nice regard for these fundamental aims of tabular presentation, standardization may well be allowed to proceed as it has heretofore, through imitation of the most satisfactory existing practices. Untiring experiment with varying forms and ready acceptance of improvements are for the present the most promising means of securing better construction of statistical tables.

A CONTINUOUS CENSUS OF PRODUCTION: A ROUND TABLE DISCUSSION

Editor's Note: The Committee on Business Statistics of the Association has been engaged for several months, in coöperation with various trade associations and governmental agencies, in an attempt to formulate plans for the setting up of monthly, or other frequently compiled statistics of output in key manufacturing industries. Such statistics, if available, would be of special importance, not only in the measurement of general business activity, but also as a basis for the production, sales, and financial programs of industries whose activities were directly or indirectly related to the figures compiled. The committee held an important conference on this subject in New York City in December, and the discussion was continued later in a round table meeting at the annual meeting of the American Statistical Association in Chicago. The following account, prepared for the QUARTERLY by Mr. M. C. Rorty, sets forth the substance of this round table discussion. As the result of these meetings, the committee is now undertaking to arrange for certain specific monthly compilations.

The chairman (Mr. M. C. Rorty) opened the discussion by stating that, among the persons concerned with the measurement and forecasting of business activity, whether in a broad way or for individual industries, there was a growing demand for indices of the volume, or quantity, rather than the value of production. At present, price fluctuations are so great that statistics of values, alone, are relatively useless. Statistical series, in order to be of service in measuring business activity, must be issued at short intervals, must be promptly compiled, and, for present use, must have been in existence for a long enough period to enable reasonable allowance to be made for seasonal, if not for secular, trends. The list* that had been distributed to the members present was believed to be substantially complete as to serviceable volume indices. It would be noted that reasonably comprehensive figures were available for agricultural and mineral products, but that there was a serious lack of indices of manufacturing activity. The purpose of the present discussion was, therefore, primarily to determine what additional indices of manufacturing activity

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* Reproduced on following pages.

A LIST OF SERIES NOW AVAILABLE SHOWING VOLUME OF PRODUCTION IN THE UNITED STATES

	Unit	Description of Series	Period	*Available Since	Issued by
AGRICULTURAL PRODUCTS:					
Foodstuffs—					
Butter	Pound	Production storage	Month	1917	Bureau of Markets
Cheese	"	" "	"	"	" " "
Eggs	Case	Storage	"	"	" " "
Oleomargarine	Pound	Production storage	"	"	" " "
Cattle	Number	Number slaughtered	"	"	" " Annual Industry
Calves	"	" "	"	"	" " " "
Swine	"	" "	"	"	" " " "
Beef	Pound	Dressed meat	"	1918	" "
Veal	"	" "	"	"	" "
Pork	"	" "	"	"	" " " "
Pork	"	Storage frozen, salt	"	1917	" " Markets
Lard	"	Storage	"	"	" " "
Wheat	Bushel	Production	Year	1868	Statistical Abstract
Wheat Flour	Barrel	Production, Stocks	Month	1910	Dept. of Agriculture
Corn	Bushel	Production	Year	1868	Statistical Abstract
Oats	"	"	"	"	" "
Rice	"	"	"	"	" "
Barley	"	"	"	"	" "
Buckwheat	"	"	"	"	" "
Potatoes	"	"	"	"	" "
Sugar	Pound	"	"	"	" "
Lumber—					
Lumber	Feet	Production Shipment	Week		Nat. Lumber Mfrs. Assn.
New Business	"	Orders	"		" " " "
Textiles—					
Raw Cotton	Bale	Production	Year	1899	Statistical Abstract of U.S. Census
Raw Cotton	"	Consumption	Month	1917	Bureau of the Census
Spindles	Number	Number active	"	"	" " " "
Wool	Pound	Consumption	"	1918	" " Markets
Active Machinery	Number	Number of spindles, width of loom	"	..	" " the Census
MINERAL PRODUCTS:					
Coal—					
Bituminous	Tons	Production	Week	1917	U.S. Geological Survey
Anthracite	"	"	"	"	Anthracite Bureau of Information
Coke	"	"	"	"	U.S. Geological Survey
Copper	"	Production, Stocks	"	"	" " "
Iron and Steel—					
Pig Iron	"	Production	Month	1883	American Iron and Steel Institute
Steel Ingots	"	"	"	1901	American Iron and Steel Institute
U.S.S.C. Orders	"	Unfilled orders	"	1910	U.S. Steel Corporation
Petroleum—					
Crude Petroleum	Bbls.	Production, Stocks	"	1917	Bureau of Mines
Gasoline	"	Total output, "	"	1918	" " "
Kerosene	"	" " "	"	"	" " "
Lubricating, etc.	"	" " "	"	"	" " "

* In the case of certain series it may be possible to secure figures for an earlier date than that here stated.

should be made available, and what procedure could best be established for setting up the necessary compilations. In this respect, the present session would be a continuation of similar discussion at the dinner of the association in New York on December 12, 1919, at which there was general agreement:

A LIST OF SERIES NOW AVAILABLE SHOWING VOLUME OF PRODUCTION IN THE UNITED STATES—*Concluded*

	Unit	Description of Series	Period	*Available Since	Issued by
MANUFACTURED PRODUCTS: (Not listed above)					
Leather—					
Hides and Skins......	Number	Raw stocks	Month	1919	Bureau of Markets
Boots and Shoes......	"	Production	3 Mos.	1918	Manufacturers Assn.
Stocks...............	Pounds	Stocks on hand	"	"	" "
Paper—					
Pulp................	Tons	Production	Month	1918	Fed. Trade Commission
Paper...............	"	Production by grades	"	"	" " "
Wall Paper	"	Production	"	"	" " "
Felts and Building....	"	"	"	"	" " "
Railroad Supplies—					
Cars................	Number	Output	"	"	Ry. Car Mfrs. Assn.
Locomotives	"	"	"	"	U.S. R.R. Admin.
Shipbuilding—					
Ships................	Tons	Production, schedule	"	1917	U.S. Shipping Board
Ships................	Number	Officially numbered	"	..	Bureau of Navigation
Tobacco—					
Cigars...............	"	Production (large and small)	Month	..	Comm. of Internal Revenue
Cigarettes	"	Production	"	..	" " " "
Chewing, Smoking....	Pounds	"	"	..	" " " "
RAILROADS:					
Average miles of road operated...........		By companies and groups with totals for U.S.	Month	1917	U.S. Railroad Admin. Summary O.S. 5
Net ton miles........			"	"	
Net ton miles per mile per day............			"	"	
Train miles..........			"	"	
Net ton miles per train mile...............			"	"	
Freight car miles (loaded empty)			" "	" "	
Net ton miles per car per day............			"	"	
Gross ton miles.......			"	"	Summary O.S. 7
Passengers carried one mile...............			"	"	Summary O.S. 8a

*In the case of certain series it may be possible to secure figures for an earlier date than that here stated.

(a) That there should be made available current statistics of manufacturing output in a limited number of key industries.

(b) That the industries selected should be those of which the output can be measured accurately and readily in quantity or volume, as well as in value, and in which only a relatively small number of firms are involved.

(c) That statistics should be set up only for those industries desirous of coöperating in the compilations.

(d) That the statistics should be simple and that primary reliance should be placed upon statistics of shipments, supplemented by statistics of output, stocks on hand, etc., in those cases where the conditions of manufacture are such as to make the keeping of such records relatively easy.

(e) That the compilations, to be of value, must be handled with great rapidity; *i. e.*, on a basis comparable with that of the statistics of cotton consumption now prepared by the Bureau of the Census.

The chairman further stated that, in addition to the points on which there was general agreement at the New York dinner, there was a division of opinion as to the following points:

(a) As to the series to be set up, 38 ballots were collected at the close of the dinner, which established an order of preference as follows:

Automobiles
Agricultural implements
Textiles
Lumber
Leather
Rubber
Typewriters
Paper
Cash registers
Phonographs

Additional series, not covered by the original ballot, were suggested as follows:

	Votes		*Votes*
Hardware (tools, etc.)	4	Sewing machines	1
Moving pictures	2	Electric washing machines	1
Chemicals	1	Electric vacuum cleaners	1
Furniture	1	Electric farm lighting plants	1

In addition to the above, suggestions made after the meeting included:

Sulphuric acid
Electric motors

(b) As to the agency to be employed for compilation, 27 ballots favored governmental agencies, 4 ballots favored private agencies, and 7 ballots favored combined action.

(c) As to the period, 20 ballots favored monthly statistics, 12 ballots favored quarterly statistics, and 6 expressed no choice.

Dr. Warren S. Persons, in continuing the discussion, stated that the important thing was to determine the type of information that could be obtained readily and promptly. If practicable, this should cover the output, the number of employees, with changes in wages and hours, the unfilled orders and the time required to fill such orders when working at capacity. It would especially be necessary to sell the idea of the use of such statistics. Apparently the trade associations realize their value for their own purposes, but it will be necessary to bring home to them the wider value that the figures might have if regularly published for general use. As to the industries for which compilations should first be made, it was more important to establish the method than to select any particular lines of output. Almost any three or four industries would do at the start. Special attention should also be called to the importance of setting up the indices, in the beginning, on such basis that full use might be made of the possibilities of accurate sampling. Any attempt to await full returns from each industry would delay unduly publication of the results and would largely destroy the value of the indices as current records of industrial activity and for purposes of business forecasts. The industries involved would, of course, desire to know the total output, but this could be estimated each month from partial returns and minor corrections could be made on re-publication of the figures in succeeding months. Every effort should be made, however, to maintain continuous series, using reports from the same firms each month. Supplemental reports should be used mainly for purposes of estimating total output. Variations in the number and importance of the establishments reporting should be clearly stated when the figures are published. It will be specially important in starting each series to state fully and clearly those special features of the industry and of the method of compilation employed which might affect the interpretation of the statistics. Statistics of shipments might be sufficient for some industries, but many industries stored up output during slack seasons, and this factor could not safely be neglected.

Professor Horace Secrist agreed, in general, with Dr. Persons' observations. He saw no reason for going outside of the list of key industries selected at the New York meeting. Just how many series should be set up was problematical. The necessary support for the plan could not be obtained from industrial establishments and trade associations without definite assurances that figures for individual firms would be held in confidence and that the publication of results would otherwise be properly safeguarded. Full use should be made of sampling methods, and special attention should be given to the continuity of the series. A question existed as to the possibility of getting accurate volume indices for many industries. Changing standards and grades might seriously affect the continuity of series, and much difficulty would be experienced in combining dissimilar units of output within the same industry. The storage element was also too important to be neglected. It might be desirable to use, as a supplemental index, the percentage of total capacity in operation, as revealed by the number of employees or employee hours. In some lines of output, such as typewriters and phonographs, it might be necessary to make a distinction between output for export and output for domestic use.

The chairman stated that Professor Secrist's remarks concluded the prepared discussion, and that he would prefer to have the general discussion proceed thereafter point by point, in order that a record might more readily be made of any conclusions or differences of opinion that might develop. The plan under discussion was not at all an academic one, and if a reasonably close agreement could be reached on fundamental points, there was a very definite possibility of concrete results being obtained. First in order would be comments regarding the value of such indices as those proposed, both to business in general and to the specific industries affected.

Mr. Arthur B. Butman stated that the boot and shoe manufacturers were heartily in favor of the general plan. They particularly desired statistics as to hides and leather, but had also included provision for statistics of finished leather products in a bill now pending in Congress.

Mr. Earle Clark believed that the automobile industry, as a whole, would endorse the plan. The officers of the General Motors Corporation had expressed themselves in favor of it and Mr. Reeves, as general manager of the Automobile Chamber of Commerce, had indicated the support of that organization.

Mr. J. W. Scoville stated that the American Writing Paper Company probably would favor the setting up of statistics of paper output.

Miss Edith M. Miller felt that the banks would be particularly in favor of the plan, not only for general purposes, but also in respect to particular industries. There was much doubt as to the accuracy of existing series compiled by private agencies. Such series were much in need of investigation and test. Unfilled steel orders seemed to be affected by frequent variations in the practice with regard to the cancellation of orders. Trade practices must be definitely known before reliance could be placed on any series involving such factors.

Mr. H. N. Shenton called attention to the importance of the proposed statistics in time of actual or threatened war, or of acute industrial disturbance. Priority in transportation, coal supply, etc., could be determined with much closer regard for the general public interest.

The chairman next called for discussion of the desirability of specific indices. There was general agreement that the industries first selected should be those comprising a relatively small number of establishments, of which the output could readily be measured in quantity or volume. It was further agreed that no attempt should be made to collect statistics from industries not generally willing to coöperate in the compilations. As to automobiles, typewriters, leather and leather products, and lumber, no special difficulties were indicated. Agricultural implements were pointed out to be subject to wide variations in seasonal and export demand. Technical difficulties as to variety of output, grades, etc., were pointed out in respect to textiles, rubber products and paper. Cash registers and phonographs were believed to promise valuable indices, but might be affected by variations in export demand, which would require special consideration. Sulphuric acid was specially favored as an index, and it was suggested that statistics for the main 60° to 66° grades would be entirely significant. Electric motors of the types used for factory drives were also believed to be deserving of consideration.

Discussion was stated to be next in order in respect to the items to appear on the schedules used in reporting output. As to this point, there was general agreement that shipments should be reported in all cases; that, where statistics of shipments were not wholly significant, they should be supplemented by statistics of output, or of consumption of some primary item of raw or semi-finished material, or of purchases of the same; that stocks on hand should be secured when practicable; that orders should be secured only when significant and when such compilation was specially desired by the industry; that labor statistics should be compiled only if desired by the industry and only in such manner as might supplement rather than duplicate the work of the Bureau of Labor Statistics; and that statistics of values should be entirely omitted.

The final discussion was with regard to the compiling agencies that should be employed.

It was agreed that, even when a governmental agency made the compilations, it would be very desirable for the trade associations to coöperate continuously in the interpretation of the facts.

Mr. Clark believed that, while the Bureau of the Census should collect certain simple general facts regarding the whole automobile industry, the Automobile Chamber of Commerce would wish to collect more detailed facts from its own members. This point of view he thought would be held by other trade associations.

Mr. Scoville favored collection by trade associations, the Chamber of Commerce of the United States, or other non-governmental agencies. He called attention to the fact—in which the chairman concurred—that the vote at the New York meeting in favor of compilation by governmental agencies might have been reversed, if the balloting had been confined to representatives of the industries and trade associations.

Dr. Persons, while in general favoring collection by governmental agencies in coöperation with the trade associations, felt that a proper trial should be made of private agencies. He thought that the Harvard Bureau of Economic Research might be willing to undertake certain compilations.

Dr. Day emphasized the importance of obtaining the enthusiastic coöperation of the various trade associations, not only in the collection of data but also in the compilation and interpretation of the returns. He was of the opinion that sampling methods, interpretative estimation, and prompt publication—all of which had been mentioned as necessary features of the work—were more likely to be secured in a private office than in a government bureau. In view of this fact, and the prevailing attitude of business men toward the statistical work of the federal government, Dr. Day urged that every effort be made to give the various trade associations the alternative of furnishing their data to some central statistical office not under government control; such as might, for example, be set up by the Chamber of Commerce of the United States. Such rivalry as might develop between such an office and any government bureau charged with similar work for other industries would not be objectionable, but might exercise beneficial influences upon both services. Furthermore, the plan would not commit the project exclusively to either type of organization. Future developments might be allowed to determine which form of organization promised the better statistical results.

The chairman closed the discussion by thanking the members present, on behalf of the Committee on Business Statistics, for the many helpful and constructive suggestions received. In the light of the information now at hand, he believed that the committee could undertake to secure the establishment of a few new and important indices of manufacturing output. It apparently would be desirable to divide these between governmental and non-governmental compiling agencies, being guided in this respect wholly by the desires of the industries affected. The number of new indices should be restricted to those in connection with which the most accurate results and the fullest industrial coöperation could be secured.

REPORT OF THE JOINT CENSUS ADVISORY COMMITTEE OF THE AMERICAN STATISTICAL AND AMERICAN ECONOMIC ASSOCIATIONS

To the President and Members of the American Economic and American Statistical Associations

In the autumn of 1918 it was brought to the attention of the Secretary of Commerce that events of the past few years had not tended to increase the confidence existing between the Bureau of the Census and the American Statistical Association and the American Economic Association, the two scientific organizations most directly interested in the Census Bureau and its product, but that these associations had in fact been inclined to adopt a critical attitude toward the Bureau. Accordingly, in order to restore confidence and increase coöperation and efficiency, the Secretary of Commerce with the cordial assistance and approval of the Director of the Census, on November 18, 1918, addressed an identical letter to Dr. Wesley C. Mitchell, President of the American Statistical Association, and Professor Irving Fisher, President of the American Economic Association. This letter was as follows:

November 18, 1918.

My dear Sir:

As you are doubtless aware a Bill authorizing the Fourteenth Census to be taken as of the year 1920 has passed the House of Representatives and is pending in the Senate. We have sufficient confidence in its probable passage in substantially its existing form to warrant our addressing you on behalf of the Bureau of the Census and of the Department of Commerce as below.

It is the earnest desire of the Director of the Census that the Fourteenth Census shall mark a definite advance in quality, promptness, and in the effectiveness of the work done. The legislation has, therefore, been drawn after careful study of the previous legislation, after conference with those who have taken part in earlier work of the kind and with the approval of the Civil Service Commission in the portions which fall under the purview of that body.

The step we now desire to take is to tie up the work of this census to the best scientific thought and practice as represented through your Association and the American Economic Association. Consequently this letter is addressed to you and a letter of like tenor and date is sent to Prof. Irving Fisher, President of the American Economic Association, to request that you appoint a committee of your body to be advisory to the Director of the Census and the Department of Commerce in connection with the work of the Fourteenth Census. We suggest for your consideration a committee of three but are not particular as to the exact number save that it should be of such moderate size as to be efficient in its work.

We should deem it a pleasure, were such a committee appointed, to have it confer with the Director of the Census both before and during the work of the census itself and careful consideration will be gladly given to the suggestions such a committee might think well to make.

Awaiting what I trust will be a favorable reply, I am,

Yours very truly,

William C. Redfield,
Secretary.

Upon receipt of this letter by the officers of the two associations it was at once recognized that this joint committee might be of much practical assistance to the Bureau in confronting the great task of organizing and taking the Fourteenth Census. It was also believed that in the event of successful coöperation the example and precedent of an effective advisory committee would be likely to prove of great importance to the Government in leading to similar relationships between other Government Bureaus and scientific associations or private organizations. One of the important developments of the war had been the sudden and close collaboration between the Government and scientific and industrial interests of the nation made necessary during the emergency period, and it was pointed out by men of standing, who had come to Washington solely to be of assistance to the Government, that the time was favorable for encouraging similar coöperation in connection with a recurring and distinctly peace function of the Government. It was recognized that of all the peace-time activities of the Federal Government, taking and compiling the census was the largest.

Accordingly, at the annual meetings of the two associations, both held in Richmond the following month (December 27), a cordial response was made to this request.

The Joint Advisory Committee appointed was as follows: Representing the American Economic Association, Professor

Walter F. Willcox, Professor Edwin R. A. Seligman, and Dr. Wesley C. Mitchell; representing the American Statistical Association, Professor Carroll W. Doten, Dean Edwin F. Gay, and Mr. William S. Rossiter.

Each member of the Joint Committee was considered to be especially qualified by his experience or work, or both, to be of practical assistance to the Bureau.

At the time of the appointment of the Committee, Messrs. Gay, Doten, Mitchell, and Rossiter were still engaged in war work of a statistical or economic sort, and were therefore available in Washington for service on the Committee. By an agreement between the members and the Director, approved by the Department, the other two members not then in the Federal Service were appointed special agents of the Census at a salary of $1 per annum to permit payment of traveling expenses and a small part of their living expenses during the meetings of the Committee. As rapidly as the other members retired from active Government service, which occurred between February and June, 1919, they were one by one placed upon the same basis, so that by July all were accredited as special agents of the Census without compensation.

The first meeting of the Advisory Committee was held February 10 and 11, 1919. Mr. Rossiter was elected Chairman. The Secretary of Commerce and the Director of the Census outlined the problems of the Bureau, and the Committee took up the consideration of general questions submitted to it, which naturally related to the preliminary organization of the work in anticipation of the enactment of the Fourteenth Census Law, then ready for passage by Congress.

MEETINGS HELD

Meetings of the Joint Committee have all been held in Washington. Thus far there have been seven, on February 10, February 27, March 21, April 18, May 23, June 27, and October 31. Each meeting has covered two days, so that from the organization of the Joint Committee up to the date of the preparation of this report, the Commitee has devoted fourteen working days to its task. It has been customary to hold morning and afternoon sessions on each of the two days of the meetings and on an average twelve hours have been spent at each meeting. The meetings have been faithfully attended; at all of them at least five members were present, and at three the entire membership have been in attendance. This record of attendance was accomplished oftentimes at great personal inconvenience.

Believing that systematic conduct of Committee affairs was one essential to success, the Committee requested the Director to assign an expert statistical clerk familiar with census operations and publications to act as secretary. This was promptly done, and Miss Mary F. Griffin, an editorial expert of the Division of Revision and Results, was assigned to this service. Miss Griffin has had charge of the preparation of proceedings and various memoranda and of much of the Committee's correspondence.

In general the opening session of each meeting of the Joint Committee has been occupied with conferences with the Director, statisticians, and other officials concerned with such subjects as were under consideration. These conferences have been followed by general discussion leading to the adoption of recommendations to the Bureau, which after the close of the meeting were transmitted to the Director.

SCOPE OF THE COMMITTEE WORK

The early meetings of the Committee naturally were occupied largely with conferences with the Director or Bureau Officials concerning plans, scope of the coming enumeration, and problems of administration. While the Committee was eager to aid in any manner, in searching for the opportunity for greatest usefulness, it took the position that administrative details and policies were the concern less of the Committee than the statistical product itself—especially the method of presentation and manner of distribution. Obviously, the former task is distinctly that of the officials in charge, for which they are responsible to the President and Congress. Hence after the earlier meetings the Committee gave consideration to the administrative side of the office only to the extent of assuring itself that the work was proceeding in such a way that the product would not be impaired. Some consideration was given (at the Director's suggestion) to the problem of securing a suitable card punch, but the Committee's advice was not accepted. (See Recommendation 27, Appendix I.) It became increasingly evident that in a careful, well worked out plan of form and content of Census published results lay the principal possibilities of Committee service. Other recommendations in considerable numbers were made and it is hoped were useful, but in submitting those relating to form and content the Committee believes that it has been able to aid the Bureau to effect real reforms.

ANALYSIS OF RECOMMENDATIONS SUBMITTED

The deliberations of the Committee took concrete form in 39 resolutions. These relate to the following subjects: Organization of personnel, 6; preliminary work in general, 3; mechanical devices proposed for use in the next census, 4; the population schedule and segregation of urban and rural populations, 6; the classification of occupations, 2 (comprising 13 subdivisions); schedules for manufacturing industries, 2; the agricultural schedules and the work of the Division of Agriculture, 4; order of publication and content of census reports, 7; methods of presentation and distribution of the results, 2 (comprising 9 subdivisions); miscellaneous, 3.

The Director of the Census welcomed the opinions of the Advisory Committee. He has extended every facility to the Committee in his power, and he expresses very earnestly his desire to secure the coöperation of the American Statistical and American Economic Associations in making the work of the Bureau most effective. To each recommendation of the Committee the Director has made response in writing. He has either accepted the Committee's judgment or has promised to give attention to the suggestions made. Of the 39 recommendations made* 17 have been substantially approved and adopted by the Bureau; 6 have not been concurred in;

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* Recommendations of the Committee:

A. Substantially approved and adopted: 1, 3, 4, 6, 8, 9, 10, 13, 14, 20, 26, 7(a), 18(1), and 28 (2).
B. Approved but not finally disposed of: 5, 15, 21.
C. Not concurred in: 12, 22, 24, 29, 7(b), 7(c), and 18(2).
D. Not yet acted upon: 23, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 18(3), 28(1).
E. No specific action required: 2, 11, 17.

and 13 seem not yet to have been acted upon. Three others were of such a nature that no definite action was called for. Several of those in the unacted on group could not be satisfactorily disposed of without considerable time and thought, but the more important have practically been accepted. This group includes the recent series dealing with the general subjects of content and methods of presentation and distribution.

The space occupied by the series of recommendations of the Advisory Committee to the Director of the Census forbids inclusion in the body of this report of progress. The entire series of recommendations arranged in the order of adoption will be found as Appendix I.

CONTENT AND PUBLICATION POLICY

Reference to Recommendations 20, 30, 32, 33, 34, 38, and 39 will make evident the particular stress laid by the Committee upon the necessity for speed of publication of census material. This need appears to the Committee the more urgent in view of the long delay in publishing the results of the Thirteenth Census. To aid in securing this object the Committee, after mature deliberation, emphatically recommended that the Director adopt the policy (outlined in Recommendations 30 and 32) of omitting from the main reports practically all text and publishing the tables as promptly as practicable. It was urged by the Committee that whatever value the text prepared to accompany tables may possess—and such text is, if rapidly prepared, usually a mere repetition of figures and therefore colorless—it was outweighed by the delay occasioned in preparation and in the proof reading and printing. Thus the Committee recommended the radical change of policy shown above, according to which the tables should be published as promptly as possible by themselves and should be followed by a series of special reports upon subjects derived from census returns that were most likely to be of practical importance to the American people, prepared under the supervision of the most competent experts obtainable. Further pursuing this subject, the Committee recommended a tentative list of subjects (as given in Recommendation No. 39) and in response to the request of the Director indicated a number of workers in statistics who would be competent to handle such reports.

In the opinion of the Committee the creation of this advisory body has been amply justified should nothing else result from their labor than the carrying out of this carefully studied and fully worked out plan of publication and separation of census reports. Too much emphasis cannot be laid upon the defects which characterized previous policies of the Bureau in these particulars. Much of the adverse criticism of the census has been due to such defects. A policy of publishing tables promptly, which means publishing results of the census at the earliest possible moment, and following these by a series of effective monographs, also published promptly, analyzing the more important census results in such a way as to make them intelligible and helpful to the largest number of people would not only afford an effective substitute for a mass of unimportant text repetition of figures, misnamed interpretative, but would mark a great step in advance in the scientific treatment of census results. The attention of the two Associations is especially invited by the Joint Committee to Recommendation 39, made at the last meeting of the Committee, and to the list of topics suggested to the Director of the Census as peculiarly timely or important. The recommendation and list are as follows:

> 39. The Committee desires to express gratification at the Director's approval of Recommendation 30, sections 3 to 6, advising that the Bureau should at once establish a policy of issuing special studies or monographs upon selected census topics of vital importance to the nation. It is increasingly of the conviction that these special studies are urgently needed to interpret the changes recorded in statistics of this disturbed period. The Committee further recommends that, as suggested by the Director, experts properly qualified to take up this important work under the supervision of Dr. Hill be secured at once. If called upon to do so, the Committee would be glad to coöperate by naming persons qualified to render such expert assistance.
>
> As a tentative and partial list of subjects appropriate for such special studies, the Committee suggests the following titles:
>
> a. Shifting of population since 1910 between sections of the country and between city and country.
> b. The growth of cities.
> c. The American family.

d. Foreign born population.
e. Native population.
f. School attendance and illiteracy.
g. Child labor.
h. Farm tenure, farm mortgages, and land values.
i. Total and average farm production and farm income.
j. Changes in farm crops and in live stock since 1910.
k. Effect of the war on manufactures and mining.
l. Total production in manufactures per wage earner.
m. Size of manufacturing establishments and form of ownership.
n. Integration and specialization of industry.

It was the opinion of the Committee that in publishing the results of the Thirteenth Census more emphasis had been laid upon the state than upon the subject, whereas it was felt that from the standpoint of the public and of scholars the state was a classification unit of decreasing importance and interest. This stress upon the state seemed to the Committee to be a reversion to the census practice prior to 1860, when the state was the primary unit in the presentation of census results. While it was thought that, in order to meet the local demand for statistics for individual states, it might be wise to continue the state supplement, it appeared unnecessary to incorporate all the state bulletins in the final reports. On the other hand, the Committee believed that the omission of the minor civil division table from the main reports at the last census had been a mistake, and recommended that this table should be incorporated in Volume I of the final reports of the Fourteenth Census.

For these reasons the Committee recommended collecting all the bulletins containing statistics of population, agriculture, manufactures, and mining for each state in separate state bulletins and dispensing with the final volumes by states for population, agriculture, and manufactures. The omission of these reports from the final volumes would save a large sum.

FORMAT OF CENSUS REPORTS

The Advisory Committee gave serious attention to the format of census reports and in considering this subject directed the preparation of a paper upon census publications which should review the general question of extent and cost of publications at the last three censuses and also discuss briefly the subject of distribution. This paper will be found as an appendix to the report of the Committee. The conclusions derived from the discussions of the subject are embodied in Resolution 31, and offer a complete publishing policy.

Much discussion occurred over the relative merits of the octavo and quarto size as regards suitability for the requirements of the census publications. In the Committee's opinion there was no question as to the superiority and value of the octavo size for reference and library use. The objection which has always interfered to prevent a change has been the inconvenience of readjusting census tables to the smaller size. For this reason the Committee concluded that the quarto size should be retained during the Fourteenth Census, feeling it would be unwise in the midst of the pressure and strain of the census period to undertake an experiment which might prove disastrous. The mere time and thought required for readjustment would be a distinct loss to already well advanced work. It was believed, however, that at the close of the Fourteenth Census period and with the taking up of intercensal special reports, the experiment as to the wisdom and effectiveness of the octavo as compared with the quarto size ought to be commenced. Should it prove a failure in connection with one or more minor inquiry, the embarrassment, delay, and expense would be comparatively small and would be well worth risking for the purpose of deciding upon the merits of the octavo size. On the other hand, if the latter should prove successful in connection with the minor reports, by the time the Fifteenth Census had arrived the Bureau would have reached such familiarity with the smaller size and its difficulties as well as advantages that the change from quarto to octavo, if deemed advisable, could easily be made in connection with the next census reports.

In order to reduce so far as possible the inconvenience of the larger size, the Committee urgently recommended that the paper used in the reports of the Fourteenth Census should be much thinner than has been used in reports of former censuses, pointing out the practicability and advantages of paper having a weight per ream of not more than 30 or 35 pounds, which would reduce the weight of the volumes by at least 25 per cent. Thus the reports of the Fourteenth Census, instead of being a bulky set of volumes, would be reduced by the practical elimination of text and the omission of certain state reports and still further by the use of thinner paper to a series of thin volumes easily handled and requiring comparatively little shelf space. This would be a boon to users and to libraries all over the country which should lead to the preservation of census reports where in the past their bulk has frequently prohibited their permanent retention. The Committee further advised the publication of a limited number of the Fourteenth Census reports on all rag paper for permanent library preservation.

CHANGE OF DATE OF CENSUS

At the date of the first meeting of the Committee, held February 10, 1919, the new law covering the taking of the Fourteenth Census was being crowded through Congress during the last days of the session. This bill passed the Senate on the last day of February, passed the House on the third day of March, and was signed by the President on the same day. Had it been possible to propose amendments, the Committee might have advised fundamental changes in Census inquiries and hence in schedules. By the time the Committee was organized, however, the bill had advanced too far to permit any consideration of its provisions. The new law directed a radical change in the date established for taking the Census. All of the censuses prior to 1910 had been consistently taken as of June first, but in order to meet changing conditions in cities due to the departure of large numbers of persons to the country by June 1, the date of the census of 1910 was changed to April 1. As this provision proved unsatisfactory for securing agricultural returns, January first was established in the new law as the date for taking the Fourteenth Census. When the subject was discussed at the hearings before the committees on the census of both Houses, arguments in favor of the change, especially the advantages resulting from a much more satisfactory date for agricultural statistics, were regarded by the Bureau as outweighing the disadvantages. This was perhaps one of the provisions upon which, had the Committee been in existence earlier, it might have advised a different decision, since the brief references to this subject which were made at the first meeting of the Committee developed considerable skepticism as to the wisdom of the change of date. Aside from the practical aspects of the problem there will be a persisting error in consequence of this change due to the fact that the average user of statistics will make direct comparisons between the Fourteenth Census and the Thirteenth, Twelfth, or any other census without allowance for differences in the dates or in the length of the intercensal periods. A greater objection, however, has developed already in that the change in date from April to January is tending to embarrass the Bureau, by adding to the cost of enumeration and by causing delay owing to the difficulties of travel in the midst of winter. It thus increases the burden upon officials already overburdened with the great task of taking the census.

THE ASSISTANT DIRECTOR OF THE CENSUS

At the request of the Director of the Census the Committee made an effort to advise in the selection of an Assistant Director of the Census to be appointed when the Census Act took effect July 1. Many names were suggested, but it was found that every one of those who were proposed by the Committee was fully occupied elsewhere and unable to give consideration to the claims of the Bureau. Subsequently the Department and the Director decided to invite Mr. Wm. M. Steuart to become Assistant Director of the Census. Being familiar with his excellent previous record as an official of the Census for many years and having confidence in his ability to fill the position satisfactorily, the Committee gave cordial approval to the nomination. Mr. Steuart began his work early in the summer and, with his knowledge of and experience in census work, has proved an invaluable acquisition to the Bureau in preparing for the Fourteenth Census. The position of Assistant Director of the Census has always been a very difficult one. It is a temporary position which involves supervision of permanent officials and employees.

CENSUS DEFECTS

In presenting this report of progress it is appropriate to refer to certain phases of census problems which have impressed the Committee.

Some lack of foresight and organization was shown by the Department of Commerce in arranging for temporary accommodations in connection with the Fourteenth Census. According to the final adjustment, the administrative offices remain in the permanent quarters of the Bureau in the Department of Commerce Building at 19th Street and Pennsylvania Avenue, but the entire producing force, soon to number several thousand clerks, is located in part of a temporary war building at 6th and B Streets, a mile and a half away. It is difficult to exaggerate the inconvenience and waste entailed by such an arrangement. All divisions of the Bureau should be under one roof. It ought to be managed as an independent unit during the decennial census emergency. If this could not have been done, one of the war buildings nearer the Department should have been secured.

Possibly, in passing, the Committee may be allowed also to criticise weakness shown by the Bureau itself in delaying to begin in proper season preparations for the enumeration. Little was done until the Assistant Director was appointed and took office. This resulted in pressure and some delay. It should be noted, however, that the period intervening between the date when the decennial census appropriation became available and the date of the census is three months shorter than at the last census and six months shorter than at the Twelfth Census.

Organization for the immense task of handling the field work and correspondence of the Population Census was also poor. At least one of the Bureau divisions when next confronted by a decennial census enumeration should be completely reorganized by distribution of duties on the principle of modern business organizations of large magnitude. These, however, are details of administration for which the officials of the Department or Bureau naturally are responsible and were not and ought not be within the sphere of an advisory committee.

PECULIAR PROBLEMS OF THE FOURTEENTH CENSUS PERIOD

No Director of the Census in the past in undertaking a decennial enumeration has been confronted with such problems of scarcity of labor and cost of work as have fallen to the lot of the present Director. Instead of receiving an excess of applications for employment on census work, he has encountered great difficulty in securing suitable supervisors and still greater difficulty in securing satisfactory enumerators in sufficient number. For the first time it has been found necessary to utilize the services of women in the latter activity. There are many localities in which the roll of the enumerators is still incomplete. To progress as far towards completing the quota as has been done, the Bureau has been compelled to use the maximum compensation allowed by law for the payment of enumerators. It should be remembered, however, that the addition of only one cent to the per capita compensation allowed enumerators for taking the census represents an aggregate extra cost of more than one million dollars. At the outset the Committee gave some attention to the matter of supervisors, and received the assurance of the Director that it was the policy of the Bureau to secure the best possible men without consideration of political affiliations. The Committee did not expect to insist on securing perfection, but has been entirely content if, with its advice and encouragement, the Bureau has made progress in improving the personnel of supervisors. The subdivision of Massachusetts into eight supervisors' districts in substitution for one in the past was criticised by the Committee and defended by the Director as being in the interest of better administration. Since he was charged with responsibility for the conduct of the census the Committee made no further criticism, feeling that he was the best judge of an operation for which he was himself responsible.

INCREASING DEMAND FOR CENSUS INFORMATION

The occurrence of the war greatly stimulated the demand for information of a statistical character relating to all manner of subjects. Much of this increased demand was a healthy growth indicating the increasing value of statistics in connection with all manner of activities. Hence, certain new inquiries ought to be encouraged. There should be, for example, a complete and accurate commercial census. A wealth of information and a vast store of statistics relating to department stores, drug stores, groceries, and all other leading trade activities could be secured, for which already there is an insistent demand. The Committee has received appeals from a number of sources to advocate the preparation of such data. There is also a demand for greater detail or more frequent enumeration in connection with inquiries which are already authorized, such as those concerning specified important industries and certain agricultural products and operations.

On the other hand, the Director of the Census, while confronted with such demands, finds his own problems of administration greatly increased even though he confine his activities to exactly those which have been customary and long authorized by Congress; he must enumerate a steadily increasing population. He is, indeed, about to include in the census of 1920 at least twenty-five million more people with all their varied characteristics than did the Director of the Twelfth Census in 1900. This means an increase in twenty years of practically one-third in the magnitude of the task. He must secure an army of nearly one hundred thousand persons to aid him, when labor cannot be obtained easily for any known operation, public or private, except at greatly increased compensation; yet the pay which the Census Bureau offers is moderate in the extreme.

In the opinion of the Committee the time is not far distant when the detail which it has been customary to offer in connection with the census of the United States must be sharply curtailed because of the mere magnitude of the task due to the growth of population and industry. It would be wise to recognize this fact and begin at an early date after the completion of the Fourteenth Census a careful and systematic study of the directions in which this curtailment can be applied. First, attention must be given to a number of tables, so as to secure a reduction which will cause the least loss and embarrassment to the users of statistics. It is evident that the great increase in cost which will unquestionably characterize the Fourteenth

Census in common with every other operation, public or private, at this period, if it persists, will tend to hasten curtailment at some point.

PRACTICAL USEFULNESS OF THE ADVISORY COMMITTEE

Ten months have now elapsed since the organization of the Advisory Committee and hence the beginning of its active coöperation with the Director of the Census. During this period the members have gladly contributed their time and best thought to the meetings. The actual cost to the Government has been very small, covering only such traveling expenses as have been incurred, and a small part of the living expenses of members during meetings. The total outlay for a full year of Committee activity will be considerably less than $1000. What return has the Bureau received for this investment and the time devoted by its officials to the demands of the Advisory Committee? Are there any concrete results to show for its labors? In short, has this Joint Advisory Committee advanced the cause of closer coöperation by proving to be of real service?

The Director of the Census sums up his impression by saying that the work of the Committee thus far has been of much service to him. He expresses the opinion that the members have formed an expert cabinet to which he was able to refer problems and from which he was certain to secure impartial advice.

The Assistant Director says that the impression he has received from his own brief observation and the comment of others has been that the Committee has keyed up the officials of the Bureau and steadied and encouraged them by forming an expert court of the last resort. Finally, the members of the Committee themselves, who have given their time, frequently at much inconvenience, feel that it has been and is an experiment worth while. To have advised and persuaded the Bureau to change the content policy with regard to census reports alone will mark a great advance and, by the omission of text, should effect the saving of a large sum.

Obviously the value of such an advisory body depends largely upon three essentials—knowledge of the subject, faithful consideration, and attendance. In those three essentials the Joint Advisory Committee of the two Associations has not been lacking. The Committee has pointed out to the Director with much earnestness that he might make his administration noteworthy and of especial service to the Federal Government and to the country by adopting such reasonable and far-reaching reforms in content and mechanical form as have been outlined. His response has been very cordial.

The Committee has pleasure in reporting that during its brief existence it has conducted correspondence with representatives of various independent organizations which have written to the Committee for information or assistance. Among these was the Chief of the Statistical Office of the Dominion of Canada, who submitted a copy of the Canadian Statistics Act and of the Regulations thereunder and expressed a desire to keep in touch with the Committee and receive any reports that it might issue.

The future work of the Advisory Committee doubtless will be comprised in occasional meetings, probably less frequently held, during the coming year, to pass more in detail on form and content, and to advise on special reports, or other subjects, as the opportunity for service develops.

FOR THE AMERICAN STATISTICAL ASSOCIATION:
WILLIAM S. ROSSITER, *Chairman,*
CARROLL W. DOTEN,
EDWIN F. GAY.

FOR THE AMERICAN ECONOMIC ASSOCIATION:
WALTER F. WILLCOX,
WESLEY C. MITCHELL,
EDWIN R. A. SELIGMAN.

APPENDIX I

Recommendations Made to the Director of the Census by the Joint Committee of the American Economic and the American Statistical Associations to Advise the Director of the Census

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1. It is the sense of the Committee that the construction of schedules is a technical task which in the first instance should devolve upon the chief statistician responsible for that inquiry. After each of the important schedules has been drafted, the chief statistician should be authorized and expected to secure the assistance of recognized experts to criticise the draft and suggest changes.

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2. The Committee does not consider its function to be that of a detailed study and analysis of schedules, but it is prepared to examine the schedules submitted and to express an opinion upon the larger questions involved.

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3. We recommend that each of the special schedules of manufactures should be reviewed and criticised by one expert or more familiar with that industry, to whom a draft of the schedule should be submitted and who then should be invited to come to the Census Bureau for a conference.

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4. We believe that the Division of Agriculture is inadequately provided with clerks qualified to help in planning and preparing for the Fourteenth Census and that steps should immediately be taken to supply this deficiency. At the earliest practicable moment the chief statistician for agriculture should be allowed to secure a group of expert special agents to assist in advance organization and training.

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5. The Committee is impressed by the fact, dwelt upon by all the officials who conferred with it, that the reduction of three months in the period before the beginning of the enumeration increases the need for the speedy development of plans and for the corresponding reorganization of the office force. Hence, in their opinion, the greatest immediate need of the Census Bureau is for additional experts in the divisions responsible for the coming enumeration to enable the chief statisticians promptly to perfect their organization.

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6. The Committee requests the Director to instruct Dr. Hill to prepare for its use a memorandum embodying the following facts:
   A. The successive stages in the organization of the last one or two censuses showing the building up of the personnel and the method of selecting appointees.
   B. Costs distributed by districts and branches of work.

7. The Committee approves the tentative population schedule as submitted with the exception that it makes the following recommendations:
   A. That columns 10 and 11, headed "Whether blind (both eyes)" and "Whether deaf and dumb," be omitted from the schedule, inasmuch as the information can and will be secured by enumerators on a special slip.
   B. That either column 20, headed "Whether able to read," or column 21, headed "Whether able to write," be omitted. The Committee would leave the choice to the Census authorities, but it expresses the opinion that the question as to ability to read is the more important.
   C. That an extra subcolumn be added under column 22 asking the "locality of birth."

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8. The general schedule for manufactures as used at the census of 1914 is approved. The Committee reaffirms its recommendation that each of the supplemental schedules of manufactures should be submitted to the criticism of expert representatives of the several industries, but would like to have the privilege of final consideration of the schedules after their revision.

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9. It is the opinion of the Committee that the number of separate inquiries in the schedule of the Census of Agriculture should not exceed 400. It recommends the immediate temporary appointment of a special expert to undertake such revision at once in coöperation with Mr. Austin, and that the report of this conference be prepared for the consideration of the Committee at its next meeting.

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10. The Committee requests the Director to assign some competent person to the task of preparing for its information a time schedule for all the divisions covering the preparation, enumeration, tabulation, and publication of reports for the Fourteenth Census and stating the clerical and material requirement at each step necessary to complete the census within the time prescribed by law, the same to form an orderly and coördinated statement of census operation and need. The attention of the Director is invited by the Committee to the fact that certain important memoranda have already been submitted to the Committee through the Director, which could form the beginning of this work.

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11. It was voted that hereafter the first business taken up by the Committee in assembling for a series of meetings shall be the reports of subcommittees and also to hear from the Director what disposition, if any, had been made of recommendations submitted to him as a result of the deliberations of the Committee at the preceding meeting.

12. The Committee has carefully considered the paragraph in the Director's letter of March 20 dealing with its suggestion that one of the two questions on illiteracy be omitted. We agree that it is important to preserve comparability with similar returns at earlier censuses but doubt that this consideration should be given decisive weight because—
    A. Illiteracy returns are subject to more error than we had thought, as is shown by the experience of the army in dealing with this problem.
    B. An estimate of the number unable to write from the number reported unable to read would probably be almost if not quite as near the truth as an enumeration.
    C. While in 1900 the answers to both questions were tabulated, in 1910 only those unable to write were tabulated. The original suggestion of the Committee thus involved nothing more than omitting from the schedule a question of which no use seems to have been made in the tabulation of 1910.

    In view of this situation the Committee continues in favor of omitting one of these questions and believes that it would be better to retain only the question "Whether able to read."

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13. The Committee approves the changes made in the agricultural schedule but refers the matter to Professor Doten to confer with the Chief Statistician for Agriculture with regard to further reductions or duplications. It approves as final any conclusions reached by them.

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14. The Committee invites the submission of an outline of the plan of organization for the Fourteenth Census referred to in the last paragraph of the Director's letter of March 20 and would be glad to receive this in advance of the next meeting in order that each member may examine it before it is brought up for consideration at the meeting.

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15. The Committee has considered the memoranda of Dr. Hill and Mr. Hunt on the problem of separating urban and rural population, notably in three New England states, one of which is New Hampshire, and has submitted these to a prominent member of the New Hampshire legislature for an opinion. Based upon the memoranda and response the Committee makes the following recommendation:

    That the Census Bureau undertake to differentiate within New England towns the unincorporated villages from the outside rural population under rules stated below:
    A. In towns where village districts have been defined under the statutes for purposes of lighting, taxation, etc., the boundaries of these districts should be regarded as the limits of the village.
    B. In other towns the selectmen should be requested by the Bureau of the Census to define the boundaries of villages within the limits of the towns so that enumerators can recognize them.
    C. In towns in which no village districts have been defined and in which

the selectmen fail to respond to the request of the Bureau, enumerators should be instructed to regard the village as extending to that point along any road leading out of the village at which the distance between any house and the next house beyond exceeds 300 feet.

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16. The Committee has inspected the mechanical equipment of the Census Bureau and has discussed the results of its observations. It was struck by the unequal development of the devices for the three stages of mechanical tabulation of population returns—card punching, sorting, and counting. Of these devices that for punching is still unsatisfactory, while the other two have been brought to a high state of perfection. The Committee urgently recommends that the antiquated pantograph punch be utilized only as a reserve and as a last resort and that steps be taken at once to summon to conference technical experts to undertake the task of making the existing automatic punch or a development therefrom a practical and effective power punch for use at the coming census. It is the confident hope of the Committee that energetic effort will overcome existing defects in such machines. It may even be possible to secure the development and manufacture of an entirely new machine if it proves to be desirable. The Committee recommends that no effort be spared to secure the improvements indicated. The Committee is convinced that considerable outlay in perfecting an automatic punch would be fully justified by ultimate economy.

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17. The Committee approves the method of ascertaining the limits of unincorporated villages in certain New England states set forth in the memorandum of Messrs. Hill, Hunt, and Sloane and expresses the opinion that they have worked out this problem satisfactorily.

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18. In view of the new and very interesting evidence submitted to the Committee with the Director's letter of April 17 and showing the probable advantage of retaining both questions on illiteracy and tabulating the answers, the Committee now withdraws its original recommendation that one of the two questions be omitted and substitutes therefor the following:

    A. That both questions be retained, the answers to both tabulated, and the results published.

    B. That efforts be made through special studies in certain small areas and by comparisons with other returns to check the accuracy of these answers and to ascertain the probable error of the census figures.

    C. That a special report on illiteracy based on this material should be prepared by the Bureau of the Census and published as soon as may be after the main reports appear.

19. The Advisory Committee has considered with interest the explanation of the Director of the Census concerning the status of devices available for punching cards required for the Fourteenth Census and has witnessed the test now in progress at the Bureau of the Census of three machines owned or controlled by the Bureau and of one submitted by a private corporation. It has also inspected the operation of certain proprietary devices adapted to such purposes in use at the Interstate Commerce Commission and at the Bureau of Internal Revenue.

The Committee recommends:

A. That following the precedents established at earlier censuses the Director of the Census appoint a commission to supervise a systematic test, upon which commission, in order to forestall criticism, one member at least should be an expert not connected with the Department of Commerce.

B. That the Powers Accounting Machine Company and any other concerns having mechanical devices adapted to punching census cards should be invited to submit their devices in competition.

C. That for the test herein recommended certain rules should be formulated which should take into account experience and differing adaptability of clerks employed.

D. In view of the fact that the punching device is far behind the tabulating and sorting machines in point of development and that this device is of vital importance, sufficient time should be allowed for a thorough test.

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20. The Committee believes that the results obtained from the schedules of population, agriculture, manufactures, mines and quarries, and forest products available for publication should be classified as to their sequence of completion in order that a plan for publication can be formulated in advance which will enable the presentation in the printed page of the results of the census as promptly and systematically as possible. To this end the Committee requests that a statement be prepared and submitted to it by the various divisions as to the expected sequence and probable time of completion of the material here specified.

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21. The Committee transmits herewith to the Director of the Census a copy of a letter dated April 5 from Mr. Malcolm C. Rorty, Chairman of the Committee on Business Statistics of the American Statistical Association, with a copy of a letter which accompanied it. The Committee approves in general the proposal set forth in the correspondence noted, but suggests that in working out the classification of industries for which statistics are to be secured pains should be taken to see that it is coördinated as far as possible with that of the Price Section of the War Trade Board, now in process of transfer to the Bureau of Internal Revenue, and with the classification in use by the Federal Reserve Board.

22. The attention of the Committee has been called to the fact that the division for collecting price statistics of the War Trade Board, which has performed a function generally recognized as exceedingly important, is about to be taken over temporarily by the Bureau of Internal Revenue and that officials of that Bureau would be entirely willing to see it transferred to the Bureau of the Census permanently. The Committee believes, and has already publicly so stated, that this division belongs properly to the Census as a part of its permanent organization. If this opinion meets with the approval of the Director of the Census, the Committee recommends that the Director make such representations to that end to the Secretary of Commerce and the Commissioner of Internal Revenue as may be necessary. The Committee further offers its services to the Director in securing any legislation that may be required to effect a transfer.

23. The Advisory Committee welcomes the Director's statement of May 19 that he would "not be averse to . . . testing the accuracy of the illiteracy statistics, especially if some simple, effective, and inexpensive way of doing it can be suggested." It believes that if in certain small areas, for example, near large universities or associations especially interested in conditions in their vicinity, the names and addresses and illiteracy returns for every person over 10 years of age should be placed in the hands of students of statistics or other volunteers for verification not long after they were gathered, much light upon the probable error of the returns could be obtained from these random samples of the population. If this suggestion should commend itself to the Bureau, the members of the Committee would be glad to coöperate in its execution.

24. The appointment clerk should be a real employment manager and should have full charge of all matters pertaining to the hiring, training, promotion, and welfare of the personnel of the Bureau. A strong, able, and experienced man or woman should be secured for this work.

25. The Committee has examined the correspondence with the Powers Accounting Machine Company and has conferred with the Director concerning the test now in progress of punching machinery and concerning his plans for selecting mechanical equipment for punching the population cards of the Fourteenth Census. It is the opinion of the Committee that the method so far employed by the Bureau may fail to insure that the most efficient device will be secured for the purpose specified. It is perhaps unnecessary to repeat that the Advisory Committee is in no way concerned with the success of any particular competitor, but is vitally concerned, and feels to some extent responsible, that the most efficient mechanical equipment possible shall be secured to carry on the work of the Census.

A. We approve the policy of the Bureau to have ample reserve of pantograph and key punches for use in the event of failure to secure a more effective device.

B. We recommend that, having such reserve provided in ample season, the Director invite the Powers Accounting Machine Company, in response to their letter of May 13, and any other concern capable of submitting a suitable punch, to construct and submit at their own expense and risk an improved punch or punches at the earliest practicable date (even as late as September 1, 1919) which shall then receive a prompt and thorough test. In the event of the evident superiority of any one of the devices thus submitted over the punches in reserve, the Committee recommends that the successful machine be adopted, but if because of time limitation a sufficient number of such machines can not be constructed in season to punch all the population cards, that as many machines be ordered as can be secured in season for use to supplement the pantograph or other punches actually available and in use.

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26. *Resolutions concerning the classification of occupations.*—Because of its doubt about the character of the returns that will be made by the enumerators the Committee favors a rather conservative policy in the classification of occupations by the office force. The following recommendations are submitted for consideration.

A. That the extraordinary difficulty and the pressing importance of securing better occupation returns be called to the attention of the Director of the Census as a special reason justifying his effort to secure a more efficient corps of supervisors, inspectors, and enumerators than the Census has had heretofore.

B. That in preparing the Instructions for Enumerators full use be made of the experience of the Thirteenth Census in an endeavor to guard against the commonest errors in reporting occupations.

C. That emphasis be put upon the importance of making accurate returns of occupations in the preliminary training given to enumerators.

D. The Advisory Committee urgently recommends that the practice of inspecting schedules in the offices of the supervisors before they are sent to Washington be systematized and extended. By way of tentative plan we suggest that there be selected from the staff of each supervisor one or more inspectors of schedules and that these men be given special preliminary training in the performance of their duties. Wherever physical conditions permit, each enumerator should go over at least his first schedule with an inspector who should pay especial attention to the occupation returns. Further all schedules should be examined and approved by inspectors before they are accepted by the supervisors from the enumerators.

E. That Mr. Edwards' plan of elaborating the standard classification of occupations by increasing the number of entries from the 428 used in Tables I–III of the report on Occupations issued in 1914 to about 600 be endorsed.

F. That as far as possible the changes made in this elaboration of the occupations classification should be so made as to keep the occupation statistics of the Fourteenth Census comparable with the corresponding figures of the Thirteenth Census.

G. That in classifying occupations the controlling criterion shall be the kind of work done: for example, greenhouse laborers, locomotive firemen, commercial travelers, carpenters, stenographers and typewriters.

H. That no separate classification by industries as in Table VI of the Thirteenth Census volume on occupation statistics be attempted; but that the information concerning the industry be utilized when appropriate to aid in forming a judgment concerning the kind of work done.

I. That, if possible, all the occupation returns be classified by a specially-trained force before cards are punched.

J. That in the report on occupation statistics an effort be made to analyze the tables thoroughly, and to present figures for the whole country and for broad geographical sections, if not for states and large cities, in which the persons following the 600 occupations recognized are classified according to

Literacy.
Marital condition.
5-year age groups, and single years up to 18 or 20.
Country of birth or mother tongue.
Class of worker—whether employer, employee, or working on own account.

There is some doubt about the value of the last-mentioned cross classification. The Advisory Committee would be glad to know what the staff of the Census Bureau thinks upon the subject.

K. That it is desirable further to have this general analysis supplemented by intensive studies of the occupations of special groups of persons, such as the following:

Blind and deaf.
Illiterates.
Negroes.
Women.
(Children, under 15 years of age.)
(Young persons, 16–20 years of age.)

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27. The Committee regrets that it cannot concur in the conclusions of the Bureau in connection with the development of punching devices or with the policy indicated in the Director's several rejoinders in response to Resolution 25 and previous resolutions on the subject. The nature of the rejoinders has convinced the Committee that it cannot render service by further recommendations on the subject.

MEMORANDUM TO ACCOMPANY RECOMMENDATION 27

In connection with recommendation number 27, the Committee desires to restate the facts which inspired the recommendations concerning card punching devices which it has submitted to the Bureau.

In 1890 the device used by the Census Office to punch the population card was a simple pantograph makeshift hastily invented by the inventor of the tabulating machine to supply an accurately punched card. The defects in this punch were small product, double punching, separate gang punching, and physical strain upon the operator.

During the decade which followed the inventor concentrated his effort upon improving the tabulating machine, and the rudimentary pantograph punch was again used at the Twelfth Census (1900).

During the succeeding decade (1900–1910) the patent rights on the tabulating devices expired and the Bureau set about developing a tabulating machine of its own and a motor driven punch. These machines were used to tabulate the Thirteenth Census, but for various reasons, one of which was hasty contract construction, the motor driven punch, known as the Powers punch, proved unreliable and a large part of the population cards of the Thirteenth Census were again punched with the old pantograph hand device.

When the Advisory Committee began its work it was informed by the Director of the Census and the Chief Clerk that the Census had further developed the tabulating and sorting machines to a high degree of efficiency, but that the Bureau was beginning a test of punching devices adapted to punch Fourteenth Census population cards. The competing machines were to be as follows:

a. A Powers punch repaired for the test by the Bureau of Standards.
b. An original pantograph punch.
c. A pantograph punch reinforced by a self-feeding and locking device.
d. A key punch submitted by the Tabulating Machine Co. (necessitating a different arrangement of characters on the card).

The Committee inspected this test shortly after it began. The members felt that none of the machines included in the competition was adequate and that the test was likely to be misleading and unsatisfactory. This impression was strengthened by the fact that when the Committee asked why the Powers Company, which manufactures punching and tabulating devices based on the Census motor driven punch, had not been invited to compete, ignorance of the Company's whereabouts was professed, but by using the telephone the Committee secured the presence at their meeting of a representative of the Powers Company within half an hour.

Consideration of this problem by the Committee resulted in these conclusions:

a. While great progress had been made in the development of Census tabulating and sorting machines, none had been made in machines for punching population cards if no substitute were now available for the pantograph hand punch of thirty years ago. The members further believed that the defects in this device were so obvious that good administration required definite improvement before the Fourteenth Census.

b. The proposed test included only one machine which was offered in good faith (the key punch). The other three devices were two pantographs competing against each other, and a defective Powers motor punch not capable of service without radical change.

c. The Committee also criticised the organization and conduct of the test, and felt that for the reasons noted, broad conclusions therefrom would be of small value.

Accordingly they recommended immediate conference with the Powers Company, and any other concern capable of offering a punch superior to those submitted, and the energetic application of the resources of the Bureau to develop a punch which would increase product, reduce error, and facilitate operation.

The responses of the Bureau to the Committee's recommendations have been such as to lead to the comment with which this rejoinder begins.

The Committee concludes its references to this subject by expressing the opinion that the Bureau is and will continue to be open to grave criticism as long as it utilizes for the great task of punching the cards of a decennial population census a slow and painfully operated device, thirty years old and admittedly only a makeshift when it was originally constructed.

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28. The Committee notes with gratification the Director's substantial acceptance of its various recommendations regarding occupation statistics. The only comment it wishes to add concerns the statistics of occupations of young persons by single years.

The Committee recommends:

a. That the occupations of workers under 16 years of age by single years, which were tabulated but not published at the Thirteenth Census be published in the Fourteenth Census reports.

b. That corresponding statistics based on the returns for 1920 be extended, if possible, to embrace all workers under 18 years of age. Reasons for this recommendation are the growing importance of and interest in

a. Vocational training.
b. "Blind alley" occupations.
c. State regulation of part-time employment of young persons (many states now have laws of this character applying to all persons up to 18 years of age).
d. The desirability of facilitating comparisons of this character at future censuses.

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29. The Advisory Committee has given careful consideration to the Director's statement of June 24 relating to Resolution 24 adopted at its meeting of May 23–24 and it is the opinion of the Committee that, owing to the brevity of this resolution, the Director did not fully understand the Committee's intent. It therefore desires to repeat its recommendation in greater detail as follows:

a. That a personnel office be organized.

b. That this office be under the charge of a well trained expert, experienced in the duties of employment management.

c. That this employment manager be placed under the direction of and made responsible to the Chief Clerk in the conduct of his office.

d. That the employment manager be given control of the following branches of work:

a. Training and promotions.
b. Efficiency and service records.
c. Vacations and leaves of absence.

d. Health and sanitation.

e. Housing, lunch room, and recreation facilities.

There should be a rest room and dispensary in charge of a physician and a nurse. The physician would not need to be in constant attendance, but a competent trained nurse should be on duty at all times when any considerable number of employees of the Bureau are at work.

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30. The Bureau of the Census is allowed by law three years in which to take the Fourteenth Census, tabulate the returns, and publish the results. The Advisory Committee is strongly of the opinion that a great opportunity is offered to the Bureau of the Census to complete the operation in less time than the three year period. Next to accuracy, speed in completing and publishing the results is the greatest service which the Bureau can render to the country. To facilitate this important result the Advisory Committee recommends:

a. That the results obtained from successive runs of the cards or from handling the schedules be published in bulletin form immediately after they have been secured, without delaying for the purposes of rearranging the material, including numerous percentage tabulations, or of inserting text beyond what is needful to make clear the meaning of the words and figures.

b. That the bulletins thus issued be combined into final volumes with the greatest possible speed, and to that end with the minimum amount of changes in tabulation matter and little, if any, extension of text.

c. That plans be adopted at once for a series of special studies dealing with the various census topics and interpreting the latest census figures in the light of similar figures of earlier dates and other relevant matter.

d. That after the subjects of these studies have been determined, the best qualified experts should be secured to undertake them, in coöperation with the regular staff of the Bureau. The resources of the Bureau should be at their disposal so far as other demands make possible. Their preliminary work on such studies should begin at an early date.

e. The supplementary studies recommended in paragraphs 3 and 4 should be published as bulletins if feasible, and finally combined into volumes to form the closing issues of the Fourteenth Census reports.

f. That a careful study should be undertaken at once to standardize tabulations with a view to comparability, and to avoid duplications and inconsistencies in the tables of the Fourteenth Census. The Committee believes that this study and its resulting recommendations will prove of far-reaching importance to the Bureau, and earnestly recommends that arrangements be made at once with a competent expert to undertake this work.

31. *Recommendations relating to the Decennial Census publishing policy of the Census Bureau.*

After consideration of the following review of census publication operations, the Committee submits the following recommendations in connection with Fourteenth Census publications:

a. Publications of the Fourteenth Census should consist as at the Twelfth and Thirteenth Censuses, of bulletins giving advance announcement of the results of the enumeration; final reports presenting the results of the census in permanent form; an abstract to summarize and popularize census facts; and monographs or minor volumes on special census subjects.

b. The mailing list of the Census Bureau for the distribution of bulletins and final reports or volumes of the Fourteenth Census should be established by preliminary inquiry and should include:

a. Libraries containing more than a specified number of volumes.

b. Workers in statistics in colleges, universities, and schools, and in private life whose interest is enlisted to that end, such persons including the membership of the American Statistical Association, American Economic Association, American Sociological Society, American Public Health Association, National Association of Manufacturers, and other similar organizations.

c. Certain Federal, state, and municipal officials.

d. Names of persons submitted by senators and representatives (not to exceed approximately ten names of citizens or organizations to each such official) conforming to certain standards of interest in statistical research expressed in response to inquiry by the Director of the Census as to their desire to receive Census publications.

e. A limited list of clubs and institutions, such as Chambers of Commerce and Boards of Trade, responding to appropriate inquiry.

f. A special list in each state to which only bulletins relating to the state are to be sent.

The circular letter of inquiry should list and describe the bulletins and final volumes explaining especially the value and cost of the latter, inviting legitimate requests for any or all of the publications. The mailing list for both classes of publications should be such as to secure wide and effective distribution.

c. The mailing list for the abstract should be that established in paragraph (2), with such additions as may prove advisable because of the popular character of the publication.

d. Bulletins should be printed on machine finish paper of standard weight. Volumes should be printed on thin paper of good quality not exceeding 30 or 32 lbs. per ream of 25 x 38 size. By following this policy the weight of a volume approximating 1,200 pages would not exceed five pounds.

e. A certain number of copies, possibly 1,000, should be printed on paper which will show little effect from the passage of time, such as all rag or Japanese parchment. These copies should go to Government depositories and to Government offices and important libraries.

f. The binding of the final reports and of the abstract of the Fourteenth Census should be in dark brown cloth stamped in aluminum.

g. To the end that all possible saving of time may be effected, it is recommended that practically all so-called interpretative text be omitted from the bulletins and reports of the Fourteenth Census and that no text be printed in the bulletins and final reports that is not needed to clarify tables or to prevent misconstruction of figures, and that all interpretation be reserved for special studies.

h. The Fourteenth Census abstract should be of octavo size printed on thin paper and should contain not only decennial census data but other figures derived from intercensal investigations sufficient to make the volume a complete record of recent census results. The Committee recommends that the Director of the Census secure the services of an expert in such compilation at an early date, to follow census publications closely so that the abstract may appear at the earliest practicable date after completion of census returns.

i. Rigid economy should not be the first consideration in connection with the presentation and distribution of Fourteenth Census publications. Instead the first consideration should be a reasonably wide distribution of results. To avoid all extravagance, to secure estimates, and to conduct census publishing with prudence and intelligence is, as a matter of course, assumed to be essential to good administration. But the desire to hold down publication expenditures to some arbitrary figure should not be permitted to stand in the way of the larger objective of distributing the decennial account of stock of the nation in reasonably generous fashion to the American people.

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32. The Committee reaffirms its recommendation to omit from bulletins and reports to be published within the decennial census period all text not required to explain or qualify tables. This restatement is based upon the increasing conviction that speed in securing and publishing the results of the Fourteenth Census so far as it is consistent with accuracy is the most important objective to be secured. To that end the results of the population census should be published in bulletin form in the order in which the successive runs are completed without delaying for the rearrangement of tabular matter or the preparation of text.

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33. The Committee recommends the publication of state bulletins giving the population by minor civil divisions as rapidly as the completion of the data permits. The entire minor civil division table should be subsequently incorporated in Volume I, in accordance with the uniform practice prior to 1910. The series of minor civil division bulletins should be followed by other series of topical population bulletins

presented by states or groups of states substantially in the order of the tabulation.

34. The Committee recommends that the statistics of agriculture be tabulated by topics and that the first tables prepared and published be those relating to farm acreage and values and the second those relating to farm crops and live stock on farms.

35. The Committee approves the Division of Agriculture's policy of including returns of farms located within city limits in the agricultural tables for the county in which the specified city is located.

36. The Committee recommends that if the Census Bureau regards it as advisable to use for any geographical unit crop values obtained in the form of averages from the Department of Agriculture the results be shown by counties. The Committee is inclined to believe that if the Department of Agriculture plans to publish crop values in any detail, the publication of these same figures by the Census would tend to duplication and might be unwise.

37. The Committee further recommends that all bulletins containing statistics of population, agriculture, manufactures, and mining for each state should ultimately be brought together in separate state bulletins and that a limited number of these bulletins should be bound as volumes for distribution to depository libraries.

38. The Committee recommends that Volumes II and III, Population, Volumes VI and VII, Agriculture, and Volume IX, Manufactures (so far as the material appears elsewhere), as constituted in the Thirteenth Census reports, be omitted from the Fourteenth Census, inasmuch as all the material which would otherwise appear in three volumes of the Fourteenth Census would appear—if Recommendation 37 is adopted—in bound volumes of bulletins. Original data, if any, now appearing in the state sections should be presented in the general reports.

39. The Committee desires to express gratification at the Director's approval of Recommendation 30, section 3 to 6, advising that the Bureau should at once establish a policy of issuing special studies or monographs upon selected census topics of vital importance to the nation. It is increasingly of the conviction that these special studies are urgently needed to interpret the changes recorded in statistics of this disturbed period. The Committee further recommends that, as suggested by the Director, experts properly qualified to take up this important work under the supervision of Dr. Hill be secured at once. If called upon to do so, the Committee would be glad to coöperate by naming persons qualified to render such expert assistance.

As a tentative and partial list of subjects appropriate for such special studies, the Committee suggests the following titles:

a. Shifting of population since 1910 between sections of the country and between city and country.
b. The growth of cities.
c. The American family.
d. Foreign born population.
e. Native population.
f. School attendance and illiteracy.
g. Child labor.
h. Farm tenure, farm mortgages, and land values.
i. Total and average farm production and farm income.
j. Changes in farm crops and in live stock since 1910.
k. Effect of the war on manufactures and mining.
l. Total production in manufactures per wage earner.
m. Size of manufacturing establishments and form of ownership.
n. Integration and specialization of industry.

APPENDIX II

PERSONNEL OF THE JOINT ADVISORY COMMITTEE

Carroll W. Doten, Professor of Economics, Massachusetts Institute of Technology, Cambridge, Massachusetts. For many years Secretary of the American Statistical Association; actively connected with the Census Bureau during the Thirteenth Census period (1909). At the time of his appointment was a member of the staff of the Central Bureau of Planning and Statistics in Washington.

Edwin F. Gay, President of the New York Evening Post, Incorporated. Former Dean of the Harvard Graduate School of Business Administration; specialized in Economic history. At the time of his appointment Director of the Division of Planning and Statistics of the Shipping Board, Chairman of the Division of Planning and Statistics of the War Industries Board, Director of the Central Bureau of Planning and Statistics, member of the War Trade Board and other important war-time organizations.

Wesley C. Mitchell, Professor New School of Social Research; President of the American Statistical Association, 1917–18; connected with the Census Office 1899–1900. At the time of his appointment engaged in important economic work for the Government related to war activities. 15 Washington Square, New York City.

William S. Rossiter, Chairman, President of The Rumford Press, Concord, New Hampshire. Expert special agent or Chief Clerk of the Census 1900–1909 (during the Twelfth Census and subsequent period). Author of "A Century of Population Growth in the United States, 1790–1900" and papers upon statistical subjects. At the time of appointment was a member of the staff of the Central Bureau of Planning and Statistics in Washington.

Edwin R. A. Seligman, McVickar Professor of Economics and Finance at Columbia University. Former President American Economic Association. Member of the Commission on Federal Statistical Reorganization, 1908; author of many works on economic and statistical subjects. 324 West 86th Street, New York City.

Walter F. Willcox, Ithaca, New York. Professor of Economics and Statistics, Cornell University. Former President of the American Statistical Association and the American Economic Association; long connected with the Census Office as an official of the Twelfth Census and expert writer; prepared a number of census reports. Consulting Statistician, New York State Department of Health; actively engaged in statistical and census work.

PROCEEDINGS OF THE 81ST ANNUAL MEETING
OF THE
AMERICAN STATISTICAL ASSOCIATION
CHICAGO, ILL., DECEMBER 29–31, 1919

PROGRAM

Monday, December 29.

8 p. m.

Presidential Address:

The Essentials of a Good Census: Joseph A. Hill.

Tuesday, December 30.

10 a. m.

The Improvement of Criminal Statistics in the United States: Louis N. Robinson, Probation Officer of the Municipal Court of Philadelphia.

Discussion by A. J. Todd, Labor Manager, B. Kuppenheimer & Co.

The Bureau of Criminal Records and Identification: Robert H. Gault, Editor of the American Institute of Criminal Law and Criminology.

Fighting Crime in Chicago: Henry Barrett Chamberlin, Operating Director of the Chicago Crime Commission.

2.30 p. m.

Round Table Discussion on the subject of a Continuous Census of Production: Led by M. C. Rorty, Statistician, American Telegraph and Telephone Company.

Discussion by Edmund E. Day, Warren M. Persons and Horace Secrist.

8 p. m.

Business Meeting: Election of Officers, Reports of Committees, etc.

Wednesday, December 31.

10 a. m.

Cost of Production Statistics: Lewis H. Haney, Director of the Bureau of Research and Publicity, Southern Wholesale Grocers' Association.

Discussion by M. C. Rorty, and Wesley C. Mitchell.

Progress in Railway Cost Accounting: Julius H. Parmelee, Statistician, Bureau of Railway Economics.

An International Price Index: Maurice L. Jacobson, Statistician, Federal Reserve Board.

2.30 p. m.

Scope of Statistical Research: John Cummings, Statistician, Federal Board for Vocational Education.

Standardization of Statistical Table Structure: Edmund E. Day, Harvard University.

Statistical Standards in Business Research: Horace Secrist, Northwestern University, Director of the Bureau of Business Research, Chicago.

Methods Employed in the Construction of Infant Rates of Mortality in the United States Life Tables: James W. Glover, University of Michigan.

MINUTES OF THE ANNUAL BUSINESS MEETING

Meeting called to order at 9 p. m., December 30, 1919, President Joseph A. Hill presiding.

Minutes of four regular meetings of the Board of Directors, held January 14th, March 28th, May 15th, and October 3d, 1919, were read and approved.

Reports were submitted as follows:

SECRETARY'S REPORT

The following report is submitted in respect to the condition of the Association:

Membership December, 1918				812
Additions during 1919:				
New members	200			
Corporate members	3			
Total		203		
Deductions during 1919		146		
Net gain during 1919				57
Membership December, 1919				869
Besides members we have:				
Subscribers, mostly libraries			242	
Domestic exchanges			40	
Foreign exchanges			71	
Total members, subscribers and exchanges				1,222
Above deductions during 1919 grouped as follows:				
Deaths reported, including four honorary members			20	
Resignations at first of the year			36	
Resignations during year			13	

*Not found	27
Not found since January, 1919	6
Dropped for non-payment of dues, 1914–19	44
Total	146

The death of the following members has been reported during the year:

Honorary members:

Dr. Louis Gillaume, Berne, Switzerland
Andere Nicolai Kiaer, Christiania, Norway
Dr. Egisto Rossi, Ellis Island, New York
Dr. Gustav Sundbärg, Stockholm, Sweden

Regular members:

- Hon. J. H. Barton
- L. S. Blakey
- John J. Brinkerhoff
- Reginald L. Brown
- William E. Butler
- Andrew Carnegie
- Edwin W. DeLeon
- Victor M. Kime
- Benno Loewy
- Wm. A. McKenzie
- Edward D. Page
- Thomas E. Pickett
- Carl Schloss
- Alonzo W. Shunk
- Alexander M. Wilson
- John B. Worcester

Four numbers of the PUBLICATIONS have been issued, containing an aggregate of 331 pages. A handbook has been published as a supplement to the December issue, containing the names, addresses, and business connections of members.

Three special meetings of the Association have been held in New York City during the year, in March, June, and December. Attendance 50, 60, and 95 respectively.

A special study of 610 members has been made from the new membership blanks as directed by the board. The remaining 247 members did not fill out the blanks.

A further distribution was made according to whether the members had had formal statistical training, through instruction in courses in some institution, or training through practical experience only. Only 271 out of the total of 610, or about 44 per cent, described such formal training on the blanks. On the other hand, about three-fourths of the total, 450 members, were shown to be graduates of some college or university. The following summaries are presented:

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* During the year 1919 an effort was made to clear the rolls of uncertain addresses, etc. A special letter was sent to all members who were delinquent in their dues for some part of 1914 to 1917, as well as 1918 and 1919. The 27 and the 6 designated as "not found" were dropped because their letters were returned unclaimed. The 44 mentioned as "dropped for non-payment of dues" were so designated because they did not reply in any way to the special letter sent to them requesting their coöperation and support. No one was dropped who was delinquent only for 1918 and 1919.

DISTRIBUTION OF 610 MEMBERS OF AMERICAN STATISTICAL ASSOCIATION ACCORDING TO OCCUPATIONAL CONNECTIONS AND ACTIVITY IN STATISTICAL WORK

Connections of members		*Number*	*Active**	*Not active*	*Per cent of total in larger groups*
1. Business:					
(1) Banks	21		10	11	
(2) Insurance	115		102	13	
(3) Manufacturing	52		39	13	
(4) Trade	28		20	8	
(5) Transportation and communication	25		19	6	
(6) Other business	41		28	13	
Total business		282	218	64	46
2. Colleges and Universities		98	62	36	16
3. Government bureaus (not functioning as a business)		138	122	16	23
4. Private social organizations		43	31	12	7
5. Miscellaneous					
(1) Legal	13		2	11	
(2) Medical	11		7	4	
(3) Other	25		7	18	
Total miscellaneous		49	16	33	8
Grand total		610	449	161	100

ANALYSIS OF THE ENTIRE PRESENT MEMBERSHIP NUMBERING 847, EXCLUSIVE OF CORPORATE AND HONORARY,† ACCORDING TO YEAR OF JOINING THE ASSOCIATION, GROUPED BY FIVE-YEAR PERIODS.

Year	*Number*	*Year*	*Number*
1919	200	1899–1903	13
1914–1918	278	1894–1898	23
1909–1913	194	1889–1893	53
1904–1908	56	Unknown	30

* By *active* is meant any work with statistical data such as that done by executives in planning, the chief statistician, research workers, graphic work and clerical work with statistical data. This group constituted about 74 per cent of the total.

† There are 19 honorary and 3 corporate members.

Geographic Location of the Entire Membership Exclusive of Honorary and Corporate, by Large Cities and by States

By Cities

New York City	245	Baltimore	15	San Francisco	5
Washington	116	Pittsburgh	10	Cincinnati	4
*Boston	38	Detroit	9	Minneapolis	4
Chicago	36	Newark	8	St. Louis	3
Philadelphia	30	Cleveland	5	Milwaukee	2

By States†

Alabama	1	Massachusetts	89	South Carolina	1
California	11	Michigan	13	South Dakota	1
Colorado	3	Minnesota	9	Tennessee	3
Connecticut	27	Missouri	6	Texas	5
Delaware	1	Nebraska	4	Vermont	3
District of Columbia	117	New Hampshire	3	Virginia	5
		New Jersey	28	Washington	3
Georgia	2	New York	285	West Virginia	2
Illinois	51	North Carolina	3	Wisconsin	7
Indiana	6	North Dakota	1	Wyoming	1
Iowa	6	Ohio	21	Hawaii	3
Kansas	3	Oklahoma	2	Philippines	1
Louisiana	1	Oregon	1	Canada	14
Maine	2	Pennsylvania	56	Others	17
Maryland	21	Rhode Island	8		

Respectfully submitted,

ROBERT E. CHADDOCK,
Secretary.

Report of Secretary accepted and ordered printed in the proceedings.

REPORT OF TREASURER FOR 1919

RECEIPTS

Membership dues		$2,709.20	
Sales and subscriptions of QUARTERLY		907.93	
Memorial Volume:			
Sales to members	$274.60		
Sales through Macmillan Co.	388.74		
Total		663.34	
Dividends on B. & A. Stock		151.96	
Balance on hand, general fund		183.35	
Balance on hand, Memorial Volume funds		39.48	
Loan made February 1, 1919, Corn Exchange Bank (To pay old loan from Boston Bank)		1,500.00	
			$6,155.26

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* Does not include Cambridge.

† Arizona, Arkansas, Florida, Idaho, Kentucky, Mississippi, Montana, Nevada, New Mexico, Utah, have no members.

EXPENDITURES

Printing:			
Printing QUARTERLY PUBLICATIONS:			
September, 1918, balance due	$192.36		
December, 1918	293.95		
March, 1919	385.90		
June, 1919	316.87		
September, 1919	611.28		
Total	$1,800.36		
Printing, balance in full, Memorial Volume	537.75		
Other printing expense, stationery, etc.	293.88		
Total printing expenses		$2,631.99	
Postage		304.41	
Salaries		843.30	
Loan paid in full to New England Trust Co., Boston, Mass., for Memorial Volume		1,500.00	
Interest on $1,500 loan during 1919		99.00	
Expenses, miscellaneous		117.09	
Balance forward		659.47	
			$6,155.26

ASSETS

17 shares Boston & Albany R. R. stock, deposited with Corn Exchange Bank as collateral for $1,500.00 loan, for the Memorial Volume.

About 675 copies of the Memorial Volume, valued at approximately $2,200.00.

REPORT ON MEMORIAL VOLUME FUND, 1919

RECEIPTS

Balance received from Boston banks	$ 39.48	
Sold 78 volumes to members at special rate	274.60	
Sales through Macmillan Co.	388.74	
		$702.82

EXPENDITURES

Balance due Rumford Press (in full for volume)	$527.75	
Printing circulars	10.00	
Express charges on volumes to Macmillan	9.96	
Interest on $1,500.00 loan during year	99.00	
Balance forward (Forms part of general balance of Association)	56.11	
		$702.82

Payable

The Association has $1,500.00 loan on account of the Memorial Volume still outstanding.

Assets

The Association has about 675 copies of the Memorial Volume which should be valued at approximately $2,200.00.

Robert E. Chaddock,
Treasurer.

AUDITORS' REPORT

We have audited the accounts of the Treasurer of the American Statistical Association as of the close of business December 9, 1919, and find all disbursements properly accounted for by cancelled checks and vouchers. We have also verified the treasurer's record of receipts and disbursements, as shown by his books, with the cash balance on hand, as shown by the bank statement, and find the same in agreement.

As is customary, we have made no audit of accounts payable and receivable.

M. C. Rorty,
E. W. Darling,
Auditing Committee.

The reports of the Treasurer and the Auditing Committee were accepted and ordered printed in the proceedings.

REPORTS OF COMMITTEES

Report of the Joint Census Advisory Committee of the American Statistical and American Economic Associations.

This report was accepted and ordered published in the proceedings, and will be found on page 76 of this issue.

REPORT OF THE COMMITTEE ON FEDERAL STATISTICS

W. A. Hathaway, chairman of the committee, presented the following report of progress:

Two resolutions or recommendations were referred to the Committee on Federal Statistics by the Board of Directors of the Association, with instructions to investigate and report. These two matters related to the establishment in Washington of a centralized statistical bureau, or some agency for coördinating the statistical work of the government.

The chairman of the committee forwarded these two resolutions to each member of the committee and asked for an individual expression of opinion on them, with suggestions for a method of procedure for work of the committee looking toward a final report on the two resolutions, and also regarding any other work to be taken up by the committee during the year. Replies were received from each member of the committee. The chairman also consulted with two members of the committee in person and made some tentative inquiries and investigations in Washington relating to the subject. The results of the foregoing activities may be summarized briefly as follows:

(1) That actual centralization of governmental statistical work, *i. e.*, collection, compilation, and distribution, is probably neither desirable nor feasible.

(2) That better coördination of governmental statistical work is desirable and feasible to the end that duplication of work be minimized and the statistical product of the various governmental bureaus be vitalized and given wider distribution to the consuming public.

(3) Considerable difference of opinion exists as to how coördination can best be accomplished. Unanimity of opinion seems to exist for the establishment of a sort of central statistical clearing house composed of representatives from the different governmental statistical bureaus, various scientific societies and associations, and business and commercial associations, etc. But on the point of whether such a central agency should have only an advisory function or be given plenary powers, there is considerable difference of opinion.

In order to accomplish anything really worth while with regard to these plans, it will be necessary to have concerted action on the part of the various governmental bureaus and other interested agencies; and it even may entail legislative enactments. Conditions in Washington during the past year have not been favorable for undertaking any large or far-reaching program of this kind. It is the opinion of the chairman of this committee (and one in which I believe all the other members of the committee would concur) that the line of procedure which would promise the best results would be for the American Statistical and American Economic Associations to appoint a joint committee on this subject, such committee to organize and invite the active assistance and coöperation of representatives of the governmental statistical bureaus, the United States Chamber of Commerce, and other similar associations. After such organization was perfected, the whole question should be thoroughly studied and surveyed by means of sub-committees with a view to the preparation of a final comprehensive report that should embody the best thought on the subject, point out the evils and deficiencies of the present situation, and recommend remedial action.

That there is need for improvement in the statistical work of the government, no unbiased thinker can truthfully deny. The situation at present is probably worse than in pre-war times, since there are many stray ends of war activity existing. But the situation is not now, and never has been as bad as it has been pictured by various persons at different times; for example, a severe arraignment of the inefficiency and great duplication of governmental statistical work by one of our Congressmen in an article which recently appeared in the *Saturday Evening Post*. Almost all such attacks are unwarranted and are based either upon ignorance of the true situation, or upon the error of judging the whole by a few bad examples.

The report of progress was approved, and the suggestion of the appointment of a joint committee with the American Economic Association was referred to the board with power.

REPORT OF THE COMMITTEE ON BUSINESS STATISTICS

For the committee, M. C. Rorty, chairman, presented the following report:

The Committee on Business Statistics, during the past year, has made a special attempt to determine, through direct contacts with business and industrial concerns and trade associations, the directions in which it might work to best advantage. Very effective support has been secured through the efforts of Mr. Zenas W. Carter, secretary of the Material Handling Machinery Manufacturers' Association who has acted as chairman of a sub-committee on coöperation with trade associations.

The result of these contacts has been to indicate that the committee could do work of greatest immediate value to business and industry by concentrating its efforts on securing adequate monthly statistics of the manufacturing output of a limited number of key industries.

Work along these lines has made rapid progress during the last three or four months, and full coöperation has been secured between the committee and the Census Bureau, the Federal Reserve Board, the Chamber of Commerce of the United States, the National Association of Manufacturers, and the various industries and trade associations concerned.

A detailed statement of the committee's efforts and present program will be submitted in connection with the round-table discussion that is to take place during the present meeting.

Report approved.

REPORT OF THE COMMITTEE ON MEMBERSHIP

The chairman, Willard C. Brinton, presented the report as follows:

The records of the Secretary's office show a considerable increase in the number of paid-up members as compared with the last few years of the Association's history. As soon as a definite policy is established regarding classification of members who are in arrears regarding dues, it would seem desirable to have curves plotted so that the rate of the growth of the society can be accurately judged. Credit for the increase in membership during the year 1919 is chiefly due to the carefully planned work of the Secretary of the Association.

It is the feeling of the chairman of the Membership Committee personally that there are very considerable opportunities for increase in the membership from the various fields of business. Certainly the growth of interest in statistics has been more apparent in the commercial field than in the academic world during the last few years. As the society proves its usefulness, and as the field for statistics expands in the business world, it should be comparatively easy to increase considerably the membership of the Association.

The final decision of the Board of Directors regarding the policies concerning corporate memberships was made so late in the year that it is not yet possible to determine just how many corporate memberships are likely to be obtained. The corporate members at present are: American Telephone & Telegraph Company; Westinghouse Electric & Manufacturing Co.; General Motors Corporation.

A number of other corporations have the matter under consideration.

It is felt that since the insurance companies depend so largely upon statistics in their regular business, they should be expected to take a considerable number of corporate memberships. It is hoped that some one familiar with insurance work will make an active campaign for obtaining insurance companies as corporate members.

Corporate members are most likely to be obtained through the personal solicitation of some member of our Association known to the corporation approached. It is suggested, therefore, that members of the Association who know officers of any corporation interested in statistical work, should volunteer to approach that corporation on the subject of taking out a corporate membership. The Membership Committee and the Secretary's office will be glad to furnish further information to assist in such a plan.

Report approved.

REPORT OF THE LIBRARY COMMITTEE

Edmund E. Day, chairman, for the Library Committee, made the following report and recommendations:

To understand the present position of the Library Committee of the Association, it is necessary to review briefly the history of the Association's library. Partly as a result of gifts of members and friends, partly as a result of exchanges of the Quarterly Publications, the Association had accumulated by 1898 a collection of about 5,000 books and pamphlets. The housing and care of the library was a burden which the Association, in straitened circumstances then as now, bore with increasing difficulty. Finally, in 1898 the Association arranged the transfer of its books to the Boston Public Library. The transfer was in effect an outright gift. Only nominal conditions were attached; namely, that "the purely statistical portion of the library should be kept together, and members of the Association should have free access to the shelves of the collection." Since there is no likelihood of a violation of these simple conditions, the Association has no effective claim upon the books formerly in its collection. With such additions as have been made, they constitute the Statistical Department of the Boston Public Library; they are no longer the library of the Statistical Association.

The Library Committee thus finds itself in an anomalous position. Not only has the Association no library, but there is no way in which the

Association can exercise any control over the books formerly in its possession. The Boston Public Library treats its Statistical Department as it deems best. Naturally, since the public call for statistical material is not as great as for other kinds of library service, the Statistical Department has received less financial support and is more poorly housed than many other departments of the Public Library. Against this situation the Library Committee can bring relatively little pressure to bear. The Library Committee can petition the authorities of the Boston Public Library for better treatment; it cannot bargain effectively for such treatment.

The only library resource of the Association lies in the exchange list of the QUARTERLY PUBLICATIONS. The exchanges of the PUBLICATIONS now go direct to Mr. Horace L. Wheeler, at the Boston Public Library. Mr. Wheeler serves simultaneously as librarian of the Association and as chief of the Statistical Department of the Public Library. Under Mr. Wheeler's supervision the exchanges of the PUBLICATIONS, after being catalogued, pass to the shelves of the Statistical Department. Practically no attempt is made to review the exchanges or to strengthen the exchange list. Thus this one remaining library resource is yielding practically no return to the Association.

If the Library Committee has any future at all, it lies in the exchange list of the PUBLICATIONS. The exchange list should be extended if possible. Important accessions obtained through exchanges of the QUARTERLY PUBLICATIONS should be promptly reviewed. In time, as more cordial relations are established between the Library Committee and the authorities of the Boston Public Library, the library authorities should be brought to see the value of the Association's contribution to the Statistical Department. Then, and not till then, will it be possible for the Library Committee to make a real contribution to the Association's resources.

In the belief that for the present the only work of the Library Committee lies in the exchange list of the QUARTERLY PUBLICATIONS, the committee makes the following recommendations:

1. That the exchanges of the QUARTERLY PUBLICATIONS be placed in charge of the Library Committee.
2. That the exchanges continue to be sent to the chief of the Statistical Department of the Boston Public Library, but be held by him subject to the direction of the chairman of the Library Committee.
3. That the librarian of the Association be also a member of the Library Committee, but not its chairman.
4. That the chairman of the Library Committee coöperate with the Board of Editors of the QUARTERLY PUBLICATIONS to revise and enlarge the exchange list and to secure satisfactory reviews of the most important volumes sent to the QUARTERLY PUBLICATIONS.

The Association approved this report, adopted the four recommendations as stated above, and ordered them to be carried out.

REPORT OF THE NOMINATING COMMITTEE

The report of the Nominating Committee, consisting of Wesley C. Mitchell, chairman, E. A. Goldenweiser and W. S. Rossiter, was presented for final action. The report previously submitted to the members by mail was supplemented by the nomination of William F. Ogburn for Editor. The Secretary was instructed to cast one ballot for the nominations as presented. The following officers were declared elected: President, George E. Roberts; Vice-Presidents, Carroll W. Doten, Lewis Meriam, Horace Secrist; Counsellors, Joseph A. Hill, Warren M. Persons, Walter F. Willcox; Secretary-Treasurer, Robert E. Chaddock; Librarian, Horace L. Wheeler; Editor, William F. Ogburn.

AMENDMENTS OF BY-LAWS

(1) The Association voted unanimously to amend by-law three, which concerns the organization of committees, to read, "The Board of Directors, as soon as practicable after their election, shall appoint two standing committees of three members each, namely, on finance and on the library; and shall appoint from time to time such other committees as in their judgment are deemed necessary for carrying on the activities of the Association."

(2) Further, by-law four was amended by unanimous vote to read, "five associate editors" instead of "four."

(3) The matter of the advisability of charging new members at the time of joining the Association an initiation fee was discussed and was not approved. However, it was voted by the Association, subject to the approval of the next annual meeting, to amend by-law two in such manner as to provide dues of five dollars for regular members and ten dollars for fellows, to become effective January 1, 1921. The discussion showed a desire to prove during the coming year that such a change is justified, by improving our QUARTERLY and extending our activity and membership. Thus, the Association will have a constantly more valuable offering to both old and new members. *Such a resolve the entire membership is called upon to support.*

The Association appropriated $600, as was provided last year, for securing assistance for the office of the Secretary-Treasurer.

The following matters were referred to the board with power:

(1) The Association voted authority to the board and its proper officers to act in the matter of the sale of stock of the B. & A. R. R. to the value of $1,000.00 for payment on the $1,500.00 loan carried for the Memorial Volume Fund, if the board deemed such sale desirable.

(2) The board was authorized to provide, either out of funds on hand or by raising special funds, for more adequate financial support of the PUBLICATIONS and for the expenses of editorial work.

RESOLUTIONS

A Special Committee on Criminal Statistics, appointed by President Hill in response to a resolution at the session on Tuesday morning, December 30th, consisting of Louis N. Robinson, chairman, and John Cummings, offered the following resolutions:

Resolved, That the American Statistical Association urge the Bureau of the Census to appoint at this time an expert in the field of criminal statistics to study the efforts which state and local officials of various states are now making to collect criminal statistics with the view to the development of a plan for the annual collection by the Bureau of the Census of criminal statistics for the United States as a whole.

Resolved, That the President of this Association be asked to appoint a committee to draft a statement to be sent to the Director of the Bureau of the Census setting forth the need for more adequate criminal statistics in the United States, and to work for the improvement and development of criminal statistics in the nation and in the individual states.

The resolutions were approved, and the President appointed Edith Abbott, Horatio M. Pollock, and Louis N. Robinson, chairman, to constitute the committee provided for in the resolutions.

The following resolutions were offered in appreciation of the services of the retiring editor of the PUBLICATIONS:

WHEREAS, the retiring editor, Mr. John Koren, has given a very great amount of time and energy to the arduous task of the preparation and editing of the Memorial Volume, "History of Statistics," as a service to the Association,

WHEREAS, he has edited the PUBLICATIONS for several years with entire devotion to the interests of the Association.

Resolved, that the American Statistical Association express its deep appreciation of the services rendered so faithfully and successfully, and directs that the Secretary publish these resolutions in the proceedings, and transmit a copy to Mr. Koren.

A report was presented by Mr. Allan H. Willett in explanation of the work of the Joint Commission on Reclassification of Salaries in Government Service. In response to his request, the Association voted to request the President, Mr. George E. Roberts, to communicate directly with the Hon. Andrieus A. Jones, chairman of the commission, setting forth the attitude of the Association in reference to the work of the commission.

ROBERT E. CHADDOCK,
Secretary.

REVIEWS

Mortality Statistics of Insured Wage-Earners and their Families: Experience of the Metropolitan Life Insurance Company Industrial Department, 1911 to 1916, in the United States and Canada. By Louis I. Dublin, Ph.D., Statistician; with the Collaboration of Edwin W. Kopf, Assistant Statistician, and George H. Van Buren, Supervisor, Statistical Bureau. New York, Metropolitan Life Insurance Company, 1919. viii, 397 pp.

Under the title given above, Dr. Louis I. Dublin, the statistician of the Metropolitan Life Insurance Company, has made a contribution to vital statistics which is of real national importance. Writing from the point of view of English experience, it surprises one not to be able to obtain year by year from official government returns an accurate and comparative statement of the mortality experience, distributed according to age and sex, and for the chief causes of death, of each chief area and of every city within the national limits. Still more is one struck with the fact that the investigation of the vital question of infant mortality is found to be almost impracticable in most areas, owing to the deficiencies of birth-registration. It is necessary of course, while bemoaning these facts, to recall the vast area of the United States, the immense difficulties in organizing the collection of vital statistics where representatives of many foreign nationalities are concerned, and the further difficulties arising from the virtual independence of each constituent state within the federal government.

But, whatever the reasons which make the accurate compilation and utilization of vital statistics in the greater part of America an aspiration rather than a reality, we have the greater cause for gratitude to Dr. Dublin for having made generally available the experience of the industrial department of the insurance company with which he is associated, for the years 1911 to 1916 inclusive. It is true that this constitutes in some respects a selected population, representing the more frugal section of wage-earners; but when we recall that the experience relates to nearly 54 million years of life exposed during the six-year period under report, it will be seen that it must form an important index of the national life of America, especially since the experience covers nearly every one of the states.

The facts tabulated relate not only to industrial men, but also to the women and children in their families; and separate statistics are given for colored insured persons. The facts are concerned with every age in life, except the first year after birth, which does not come within insurance experience. During the six years under investigation, 636,449 deaths occurred, of which 520,079 were of white persons. Evidently then, there is no fear of inferences being dubious in consequence of the paucity of the data.

As would be anticipated, the death rate at all ages among colored males was nearly 50 per cent higher than that of the white race, the greatest excess being between 15 and 20 years of age. Among colored females the excess of mortality was nearly two-thirds, the greatest excess being in the adolescent period, as for males. As shown in a later section, a large share of this excessive mortality in both sexes is due to tuberculosis, and among women also to conditions associated with child-bearing.

Comparing the insured experience with that of the registration area of the United States for a fairly corresponding period, Dr. Dublin obtained some interesting results. From ages 25 onwards, insured wage-earners show a markedly excessive death rate over that of males in the general population. In view of the partial selective influence of insurance, this is interesting. The excess of accident and sickness in industrial occupations may account for the result; but is it not possible, also, that the apparent death rate among industrial workers has been somewhat raised by a large abandonment of insurance on the part of the more favorable lives?

It is interesting to note that, in order to increase the value of its returns, the Metropolitan Life Insurance Company has adopted an extensive system of correspondence with the certifying physicians. A similar practice has been pursued for many years by the English registrar-general, and has undoubtedly done much to secure increased accuracy for doubtful certificates, and to stimulate more accurate future returns.

The chapter on tuberculosis comprises valuable material. It shows, for instance, the terrible excess of tuberculosis among the colored population, a fact which the white population cannot afford to ignore, and which calls for steady, continuous, remedial measures on their part. Here, again, it is a striking fact that among the insured the death rate from pulmonary tuberculosis was 31 per cent higher than in the general population. This does not point to any elimination by primary medical examination. It may mean merely excessive disease in wage-earners; possibly also, a disproportionate resort of weakly persons to insurance.

There follow chapters on cardiac diseases, pneumonia, various forms of accidental injury, suicide, and homicide, containing much interesting matter, but not calling for special comment.

Cancer mortality was higher among white than among colored persons, colored males showing relatively more favorable rates than colored females. As bearing on the possible influence of improved registration in showing statistical increase of cancer mortality, it is interesting to note that among white males between 1911 and 1916 the death rate per 100,000 increased from 68.0 to 70.3, among colored males from 28.9 to 36.5.

No note appears to be needed as to the chapters dealing with cerebral hemorrhage and apoplexy, communicable disease of childhood, and diarrhoea and enteritis.

The chapter on "Diseases and Conditions Incidental to the Maternal State" deserves careful study, especially by those engaged in public health work. It deals with 10,056 deaths occurring among women aged 15 to 45 years, equal to a death rate of 68.4 per 100,000 women, or 66.1 and 82.3 for white and colored women respectively. It is little short of a statistical calamity that these rates cannot be stated in *terms of the population at risk* from these special causes of death, *i. e.*, of the number of women who have borne children during the period, or of the number of births; and that similarly in most American centers of population, it is equally impossible to state by an accurate method, the risks of child-bearing, or to compare one area with another in this respect, or the same area with itself in a series of consecutive years. Subject to this serious limitation, which Dr. Dublin properly laments, there is much that is instructive in this chapter of his book; and the statement that at child-bearing ages, puerperal conditions in their entirety represent a hazard to the life of women, which is second only to that from pulmonary tuberculosis at these ages, is an urgent call to the adoption of the well-known preventive and remedial measures which would bring child-bearing more nearly to its proper position as a normal physiological event, and not a condition involving risks which are far from negligible.

In the preceding notes a few points have been brought out in relief, which have particular public health importance. The list has not been exhausted. In the absence of national returns of mortality on a similar plan, every chapter of the book can be utilized by public health officials for comparing their local mortality experience with the experience of a large section of the total population of the United States. And apart from this sphere of utility, physicians interested in any particular class of disease will find here valuable data for comparison with the results of their own experience. The subject of each chapter is carefully and soberly set forth, the limitations of the data are adequately stated, and the reviewer has failed to find throughout the volume a single statement which is not amply substantiated by the valuable statistics accompanying it.

ARTHUR NEWSHOLME.

How to Make and Use Graphic Charts. By Allan C. Haskell, with introduction by Richard T. Dana. New York, The Codex Book Co., 1919. 539 pp.

The purpose of this book as stated by the author is twofold: "(1) By giving many illustrations, to suggest to those already familiar with the functions of graphic charts new ideas for the uses of the various rulings, and (2) to show those who have never used charts at all, or but little, the principles of their use and to explain as simply as possible the many advantages to be derived by becoming familiar with this method of presenting facts."

In carrying out this purpose the author devotes the first 50 pages to the theory and construction of the various types of charts, and the following section of about 25 pages to the discussion of the general principles underlying the use of charts. The main body of the book is divided into chapters according to the branch or activity of business in which charts are used. That is to say, the material has not been grouped by types of charts but rather by subjects which charts illustrate. Because of this arrangement the book will appeal to the reader as a new approach to the study of graphic methods.

The first four chapters of the main part of the book have to do mainly with business control. Their titles are, "Organization and Management Charts," "Cost and Cost Analysis Charts," "Scheduling and Progress Charts," "Operating Characteristics." In the next section of two chapters are found special uses of charts, under the headings: "Charts Showing the Results of Tests and Experiments," "Trends, Tendencies and Statistical Prediction Shown by Charts." The two succeeding chapters, one on computing charts and the other on the use of charts in designing and estimating, cover about 150 pages, and should be especially valuable to engineers and students. The final chapter describes miscellaneous uses of charts.

The book for the most part is a compilation of articles that have appeared in business and trade publications. A few have been taken from special reports. Even though the reader may have followed these same publications pretty closely during the past few years he will be struck by the wide range of the use of graphic methods as exhibited by the contents of this book. Most of the several hundred articles bear dates within the past two or three years. One comes from the year 1893, but few of them are older than 1917. More than forty publications are represented in the list of sources, and the text is profusely illustrated by charts and diagrams.

A compilation such as this is will be welcomed because the selection of the material has been made with a definite purpose in view, and because it preserves in permanent and convenient form many articles which the reader has previously read with interest and profit, and will want to read again. In many cases, parts of the articles not dealing with charts have been omitted without loss. At the end of each chapter is a bibliography of other articles dealing with subjects related to those treated in the chapter.

The individual articles are distinguished by indented, bold faced headings, which in two or three words tell what the article is about. The name of the author of the article, the publication in which it originally appeared, the date, and frequently the full title of the article follow the heading. These same headings are gathered together in an alphabetical index at the end of the book. It is therefore possible for the reader to find the topic in which he is interested either by looking for the heading under the chapter captions, or by going directly to the index. There is also an analytical table of contents.

The book is primarily useful to engineers, but it should also be valuable as a reference and source book to all who have occasion to employ graphic methods. The chapters on logarithmic and semi-logarithmic charts will be particularly welcome. To bring together in the same volume a wealth of material pertaining to both the so-called statistical chart and to the engineer's computing chart should mark an advance in graphic methods.

There are a number of typographical errors, and a better quality of paper would have improved the appearance of the charts in a several cases, but considering the vast amount of technical detail covered and the condition of the paper market both of these defects may be excused.

Arthur R. Burnet.

Applied Eugenics. By Popenoe, Paul, and Johnson, Roswell Hill. New York, Macmillan Co., 1918. 459 pp.

This book presents an excellent summary of the need for eugenics together with the evidence regarding eugenic problems, and outlines forcefully a rational eugenic program. For the most part, the conclusions will command ready assent. The argument for race improvement, wherever race improvement can be attained by eugenic methods, is of course unanswerable. The program set forth is moderate; the restrictive measures recommended are limited to cases in which evidence is conclusive, and the positive measures are mostly educational and are aimed to promote marriage among the fittest of the population.

An impressive array of evidence is presented to show the preponderating effect of heredity over environment. One doubts the wisdom of this emphasis on a controversial question which, in the light of a forward looking program, probably was never worth debating. It is a question not of alternatives, but of complementary programs. For persons now in the world, no change of heredity is possible; so far as they are concerned, progress is dependent upon environment. For future generations, race improvement is undoubtedly a factor in progress, and of course all possible improvement in the stock should be sought; for such improvement the evidence is almost wholly in favor of heredity. Except for a relatively small field where environmental changes produce dysgenic effects, the general question as to the relative values, so far as progress is concerned, of heredity and environment, is scarcely pertinent, since problems have to be solved not by generalities, but by the facts relating to the specific case.

In regard to one such case, exception may be taken to the conclusion reached by the two authors. It is argued that infant welfare work has a dysgenic effect in that the saving of weaker infants results in the deterioration of the race. But the evidence does not warrant such a conclusion. For the reduction of the infant mortality rate has not led to an increase in mortality at ages over one year, as the theory advanced would require, but on the contrary, has been accompanied by a reduction in mortality at practically all ages. The argument is very similar to that made in reference to vaccination and smallpox in the early nineteenth century. It was then argued that vaccination was of little use, since children—"with weak constitutions"—saved from smallpox would die anyway in a few years from some other disease; but experience has showed that the reduction in mortality from smallpox did not cause an increase in mortality from other causes. Nor should it be overlooked that the decrease in morbidity, which is usually associated with a reduction in mortality, is often an important factor in reducing mortality at later ages, since many of the diseases of childhood have serious after effects and leave those who survive with weakened constitutions.

The argument under examination assumes that the fact that a child dies may be accepted as evidence that its heredity—not merely its constitution, for its constitution may be weakened by environmental causes—is faulty; but this assumption must first be proved. A death in an automobile accident is evidently not causally related to faulty heredity; and in general, faulty heredity cannot be assumed to be proved until all direct environmental causes of death or weakness have been eliminated. But the majority of infant deaths are caused by these environmental factors. In particular deaths from gastric and intestinal diseases, the most important single group of causes of death under one year, are due almost wholly to improper feeding and to infection. The effect of such improper feeding is seen not only in the mortality of infants, but also in the impaired or rachitic constitutions of young children. It is surely difficult to see how prevalence of ignorance or carelessness in feeding infants could result in improving the constitutions of the human race. Furthermore an infant's weakened condition is frequently a result of poor obstetrics or of inadequate prenatal care of the mother, and in this case also the removal of the cause should logically remove the result. The elimination of the causes of weakened infants' constitutions, the substitution of proper for improper methods of feeding, and the prevention of exposure to infection should logically result, therefore, in the improvement of the health and vigor of the race.

It is true that the authors of the book under review do not advocate the abandonment of infant welfare work; they prefer to believe that its dysgenic effects are offset by the cultivation of the feelings of sympathy and love for the weak. But the conclusion that infant welfare work has dysgenic effects seems to have been accepted without a sufficient weighing of the evidence.

In spite of these minor criticisms, the book can be recommended as a readable and well-rounded presentation of the subject, and it meets the need for a comprehensive treatment of the eugenic program.

ROBERT M. WOODBURY.

Commercial Research. By C. S. Duncan. New York, The Macmillan Co., 1919. 385 pp.

The subtitle of this book states that it is an outline of working principles. This brief characterization is well founded, as a reading of the book will show. It is neither a book of forms and illustrations nor an abstract discussion, but a practical and logical investigation of the need of business information, the methods of securing it, and the uses to which it can be put. Business men and students of business will find this book full of suggestions that are immediately serviceable.

The purpose of the book is well expressed in the preface by a series of five propositions. As the author has followed these propositions closely a repetition of them here will show what he intended to convey:

1. The immediate and primary need of business today is intelligent direction and control, individually, generally.

2. Intelligent direction and control of business can be had only by a better knowledge of business principles.

3. A better knowledge of business principles can be derived only from a careful and comprehensive survey of business facts.

4. To secure a careful and comprehensive survey of business facts is a problem for business research.

5. Therefore, the immediate and primary need of business today can be met only by business research.

This volume appears at a very opportune time because of the deep effect of the war on American business life, and because of the pressing problems of peace just now facing us. The general reader in the field of economics and business will meet in the pages of this book many thoughts and ideas that he has previously seen in print during and since the war, or that have come to his own mind when he considered the trend of affairs. But to find these same ideas so well expressed and their application so clearly and freshly pointed out in a single volume will bring great satisfaction. The statistician will discover in new form and application many of the things familiar to him from acquaintance with his text-books. In fact, this volume furnishes justification for the use of the statistical method in business. Considerable space is taken up with a constructive criticism of graphic methods.

Though not written as a text-book, it embodies several of the good features of such a book, as for example, topical synopses, at the beginning of each chapter, and indented and italicized headings at the beginning of important paragraph groups. The conclusions at the end of each chapter are not merely summaries of what has gone before, but are succinct statements of the point to which the argument has been brought.

The following summary will give the reader of this review a rough idea of the way in which the theme of the book has been developed:

In the introductory chapter covering 25 pages, the author shows how changing world conditions have brought about a new era involving complicated relationships, into which we can safely enter only with a greater knowledge of the facts. Many of the old calculations are invalid. There must be evolved new working principles based upon new analyses. It is, therefore, proposed to carry into the field of commercial organization the same attitude of scientific research that has already been applied with great effectiveness in the field of production.

The kind of research will necessarily be determined by the nature of the goods handled, and the class of business, whether wholesale or retail. The sources of business facts are either the internal records of the company or external records from governmental, trade, or other sources which are described in detail. A survey of the character of business data shows what kind of information can be secured from such sources. The business man will want to know whether the data are precise or estimated. He must also know how numerical information is affected by the classes of commodities to which it is applied, and how much faith to place in statements of market conditions, and in studies of population and wealth distribution, wages, prices, incomes, etc.

The method of collecting such internal and external statistics is given careful consideration. Statistics should be intelligently collected, and made ready for instant use. The author has a good deal to say about the proper control of data, and about the file card, letter of inquiry and questionnaire methods of securing and preserving information.

Under the heading: "Analysis of Business Facts," the author describes the statistical method, and shows why and how this method should be used by the business man. "No manufacturer or merchant," he says, "can meet his administrative problems fully without the use of applied statistics." A good deal of attention should be given to the determination of units of measurement, and to the source and elimination of errors. The author cites authorities on the various kinds of averages, and presents examples of each kind.

Great care should be used in the presentation of information, since business facts do not always speak for themselves. The use of graphic methods is commended, but observance of rules and cautions is emphasized.

Of even greater importance is the interpretation of business facts. "It means the translating of many facts of varied character and value into a plan of action, into a business policy." In this chapter the author gives a list of fifteen checks or test questions by which the interpretation of business facts is to be judged.

Another chapter deals with the various forms of organization for research. An individual may carry on the work in connection with his regular duties, or a separate department may be established. Assistance can be secured from trade associations, advertising agencies, progressive auditing concerns, and from companies especially organized to handle commercial research.

After it has been decided to go into research work, there are certain principles and rules to be observed which the author describes under three heads: the commodity, the market, and the trade organization whose function it is to get the commodity to the market. These are called the three fundamental elements of business analysis.

The closing chapter of the book, entitled "The New Business," is a splendid résumé of the factors affecting present-day commercial activity. It contains a vivid description of the sudden stimulation of business by the demands of the war, and of the effect of governmental control, price fixing, examination of the costs of production, limitation of profits. The author points out what he considers to be the persistent elements of business, and he also visualizes for us the spirit of the future.

Arthur R. Burnet.

First Annual Report of the Dominion Statistician, Fiscal Year ended March 31, 1919. Dominion Bureau of Statistics, Canada. 51 pp.

The problems of the organization of public statistics in Canada are in their broad outlines no different from those in this country. The restricted scope of government statistics, their planless origin and development, duplication in the work of statistical agencies, and varying standards of reliability, constitute a few of the problems in statistical organization which the Canadian government undertook to study and to solve. The first step was taken in 1912 with the appointment of the Statistical Commission. The function of this commission was to make a comprehensive survey of public statistical work in Canada and to formulate plans for improved organization. The outcome of the commission's investigation was the recommendation that there be established a central statistical office for the purpose of coördinating the statistical work of existing agencies. As a result of this recommendation, the office of "Dominion Statistician" was created on June 19, 1915. The incumbent of this office was charged with the direction of the statistical activities indicated in the report of the Statistical Commission. The latest phase in the application of the report of the Statistical Commission developed with the passage in 1918 of the "Statistics Act." This act sets forth the general principles of a centralized and coördinated statistical organization. It creates also the Dominion Bureau of Statistics which is primarily charged with the general administration of the act. More specifically, the duties of the bureau are "to collect, abstract, compile and publish statistical information relative to the commercial, industrial, social, economic, and general activities and condition of the people"; to collaborate with all other departments of the government "in the compilation and publication of statistical records of administration"; and to take the census.

The first report of the dominion statistician describes the organization of the Dominion Bureau of Statistics, its activities during its first year of life, and its plans for the future. Formally, the organization of the bureau is simple. Depending upon the subject matter, statistical studies are made by one of the following ten divisions of the bureau—population, agriculture, industry, foreign trade, transportation and communication, internal trade, finance, administration of justice, education, general. The last named division prepares the *Canada Year Book* and has now under consideration plans for a quarterly or monthly journal containing statistical material of general interest. The work of all the divisions is coördinated through the Division of Administration. The operation of the bureau cannot, however, be understood from a knowledge of its formal organization alone. Statistical material in Canada as in the United States is largely collected by administrative agencies in the exercise of their administrative functions, or by statistical bureaus that are only appendages of the administrative agencies. The first and most important task of any central statistical bureau consists in influencing the character of the statistical output of the administrative departments.

By an order in Council passed October 12, 1918, the nature of interdepartmental relations was outlined. All purely statistical investigations are entrusted to the bureau; the dominion statistician is empowered to recommend to administrative departments a proper procedure for the collection and compilation of their statistical records; all statistical compilations shall be made when practicable on machines installed in the bureau. The practical effect of these provisions on the work of the bureau is illustrated in the proposed annual census of industry. This census will be taken by a distinct organization which will collaborate with those departments that have executive functions in specific sections of the field. "The desideratum in such collaboration is to place the industrial technic of the administrative departments at the service of the census, and the general statistical point of view of the census at the service of the departments. Many of the latter have considerable field staffs in close touch with the industries. . . . These form the ideal substitute for the untrained enumerators of the population census" and are best equipped to collect and examine the statistics in the field. The bureau performs the function of "bringing the departments into council, planning the inquiry as a whole, . . . and generally defining methods."

The activities of the bureau are not restricted to its coördinating functions. Plans for elaborate statistical investigations into fields hitherto untouched are also under way. The most striking of these is concerned with the development of the statistics of internal trade. The bureau proposes in this case to supplement the statistics of foreign trade with data showing the movement within the country of the more important goods. Provision is also made for a large extension in the field of price statistics. To avoid duplication, the wholesale price records of the Labor Department will be merged in the bureau. Statistics will then be collected on producers' prices, wholesale and jobbers' prices, import and export valuations, the prices of securities, and retail prices. In collaboration with the Department of Labor, the bureau will undertake the construction of an index number of wages.

Students of the organization of public statistics in the United States will follow the development of the Dominion Bureau of Statistics with great interest. The existence in this country of similar problems makes the success of the Canadian experiment a matter of immediate concern to American statisticians.

Leo Wolman.

NOTES

EDITORIAL NOTE

With this issue a new editorial board takes charge of the QUARTERLY PUBLICATIONS OF THE AMERICAN STATISTICAL ASSOCIATION. The new staff hopes that the QUARTERLY will be of continually greater service to the readers and an increasingly important medium for statistical research.

To make the work more effective the broad field of statistics has been sub-divided, and each member of the board has assumed responsibility for a particular section. With this arrangement, the editors will be able to keep in touch with the various problems and with the statistical work in progress in the respective fields. Statisticians conducting researches in the various fields are invited to use the QUARTERLY as a means of publication.

The department of notes and reviews will receive especial attention. It will present news items concerning statisticians and their activities, comments on statistical organizations both in this and in other countries, and notes on current publications as well as reviews of significant books and reports. Dr. Leo Wolman has consented to take charge of this section. Coöperation not only on the part of the editors, but also on the part of the association membership will be of great aid in making this department of value. Members are urged to send to the editor's office any notes which they think of interest.

Through these plans the editors hope to make the QUARTERLY PUBLICATIONS OF THE AMERICAN STATISTICAL ASSOCIATION a journal of increasing influence in the development of statistics.

THE EDITORS.

A NEW STATISTICAL JOURNAL

The readers of the QUARTERLY will be interested to learn that a new international review of statistics is about to be issued. This will be known as *Metron* and will be under the editorial direction of Professor Corrado Gini of the University of Padua. Professor Gini will have associated with him the following editorial board:

Prof. Raymond Pearl, Professor of Vital Statistics, Johns Hopkins University.
Prof. L. March, Director of Statistics of France.
Dr. M. Greenwood, Lister Institute, University of London.
Prof. L. V. Furlan of the University of Bale, Switzerland.
Dr. F. P. Cantelli, Actuary to the Exchequer of Italy.
Prof. A. Andreadis of the University of Athens, Greece.
Dr. G. H. Knibbs, Director of the General Statistics of the Commonwealth of Australia.

The scope of this journal is not as yet entirely settled, but it is possible at this time to say that it will give a place to original articles and to reviews of the more important statistical work in the several countries. Sections of the journal will be given over to statistics as a method and as related to particular sciences, such as demography, anthropometry, economics. In addition there will be a catalogue of publications received, as well as a review of the better statistical sources. Italian, French, English, and German are the official languages of the journal. The first number of *Metron* will appear early in 1920, and we shall watch the progress of this promising publication with great interest.

American statisticians who may desire to coöperate with the directors of this journal should send their manuscripts either to Professor Pearl at Johns Hopkins or to Professor Gini at the University of Padua, Italy. Subscriptions are to be sent to the *Tipografia Industrie grafichc italiane Padova, Via Viscovado.*

L. I. D.

STATISTICS OF COAL PRODUCTION

Since the summer of 1917 the operations of the coal and coke industry in the United States have been illuminated by the publication, through the joint effort of the U. S. Fuel Administration and the U. S. Geological Survey, of statistical reports on the production and distribution of coal and coke. A few months after the entry of this country into the war, Mr. C. E. Lesher of the *Geological Survey* prepared weekly reports on the production of bituminous and anthracite coal and of beehive coke, and on the factors responsible for variations in output. This weekly statement is still being issued by the *Geological Survey;* at present under the direction of Mr. Fred G. Tryon. In September, 1919, a survey of the production of coal in 1917, prepared by Mr. Lesher, was published by the *Geological Survey.* The latest and one of the most interesting of this series of reports on the coal industry is *The Report of the Engineers Committee of the U. S. Fuel Administration, 1918–1919.* The findings of the committee were designed to serve as the basis of a scientific system of price control in the coal industry. The text of the report is devoted to a discussion of alternative theories of price regulation, and to the mode of collection and the meaning of cost data. To supplement the text, a most valuable set of charts, showing the distribution of costs in the various coal fields in the United States is appended. With the appearance of the report of the U. S. Fuel Administration and of Mr. Lesher's second volume on the distribution of coal in 1917, the facts essential to a proper understanding of the conduct of the coal industry during the war will be available.

L. W.

FOOD REQUIREMENTS AND FOOD EXPENDITURES OF MEN AND WOMEN

The desirability of apportioning food expenditure between husband and wife has occasionally arisen in connection with family budgetary studies.* The selection of the best ratio presents many difficulties.†

It would seem desirable, if possible, to establish the ratio on purely physiological grounds. The actual food requirements of men and women should serve as a basis for the establishment of the ratio. We may, therefore, direct attention to the constants recently based‡ upon precise measurements of the basal metabolism of 136 men and 103 women.

For purposes of practical rationing, the basal metabolism constant of the individual must be multiplied by the proper factor for the increase in metabolism due to activity. In the absence of information concerning this factor, which will vary according to the occupation and habits of the subject, the safest basis of comparison seems to be the basal metabolism constant.

In the volume cited it has been shown that the daily basal heat production of the average man is 1,632 calories, whereas that of the average woman is 1,349. Thus the daily heat production of woman is about 300 calories less than that of man. Expressing the relationship as a ratio we have 100 : 83.

This value makes no allowance for muscular activity. Neither does it take into account differences in the age§ of the subjects dealt with, nor differences in their size. Women are, on the average, smaller than men. In either sex, large individuals have on the average a greater food requirement than smaller ones. From the budgetary standpoint, body size is not to be taken into account. It is, however, interesting to note that the average daily basal heat production of the 136 men was 25.7 calories per kilogram of body weight, whereas that of the 103 women was 24.5 calories per kilogram; or, the two stand in the ratio of 100 : 95. On the basis of the older conventional physiological standard of estimated body surface area (Meeh), men show a food requirement per square meter of 830 calories as compared with 753 calories for women, or a ratio of 100 : 94. On the basis of the revised surface standard (Du Bois) the ratios are 925 : 850, or 100 : 92.

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* *Ann. Rept. U. S. Comm. Labor*, vol. xviii, p. 102, 1903; *Monthly Labor Rev., U. S. Bu. Labor Stat.*, Oct., 1917, p. 6, Dec., 1917, p. 6, and Dec., 1918, p. 115.

† The direct determination of the food consumption of the two on the basis of family statistics is practically impossible. Secrist (*Am. Stat. Assn. Publications*, vol. xvi, pp. 467–471, Sept., 1919) has suggested the use of cafeteria checks. As a basis for estimating the food item of annual budgets of men and women under given economic conditions, his statistics have some interest. They do not, however, seem to be of much value for purposes of determining the proper apportionment in family budgets, for the following reasons: The class of individuals is not the same. In one case expenditure is altogether individual; in the other a joint food supply is purchased. We note in short that food *expenditures* measured in this way would not necessarily represent the food *requirements* of the individual. While cost is the measure required in family budgetary studies, the division of actual cost of the joint food supply of husband and wife is more likely to represent actual food requirements of the two sexes than is the expenditures of the college, office, shopping, and theater classes in public restaurants.

‡ Harris, J. Arthur, and Benedict, Francis G., "A Biometric Study of Basal Metabolism in Man." Publication 279, Carnegie Inst. of Wash., 1919.

§ Metabolism decreases with age (Harris and Benedict, *loc. cit.*, pp. 107–127). The mean age of the 136 men is 26.88 years, whereas that of the women is 31.15 years. Since age cannot be considered in most budgetary studies this factor must be neglected.

When body weight, stature, and age (all of which have been shown to be significant factors in determining, in the statistical sense, the metabolism of the individual) are taken into account by the use of multiple prediction equations,* women show a basal metabolism rate about 6.2 per cent lower than that of man.

These values, in which correction for body size and age have been made, are inserted merely to emphasize the reality of the difference in the basal metabolism of men and women. For purposes of actual rationing, differences in size must not be disregarded. It appears, therefore, that the 100 : 90 which has been used in the past is not an unfair ratio. Probably 100 : 85, in view of the generally greater muscular activity of the man, or an even lower ratio, would more properly express the proportion assignable to husband and wife.

J. ARTHUR HARRIS.

FOOD PRICES IN THE UNITED STATES DURING THE WAR

Although the various indices are in substantial agreement as to the course of food prices in the United States during the period of the World War, confirmation of the record by data drawn from independent sources is still desirable. Such confirmation is at hand in the accounts of a large concern† which makes a business of operating restaurants in different parts of the country. The company purchases its supplies chiefly in Chicago, Kansas City, St. Louis, San Francisco, and Los Angeles. The supplies are largely foodstuffs of better grade. The purchasing records of the company thus reflect the ruling wholesale food prices in the principal western markets.

The table submitted below develops a weighted index of wholesale food prices in April, 1919, as compared with April, 1916. Columns (2) and (3) of the table give the prices paid in April, 1916, and April, 1919, for unit quantities (column 1) of 67 articles. The unit price in each case is an average derived from the company's purchases of the month. Column (4) states the number of units of the article used during April, 1919, at one of the company's restaurants. This restaurant is in a "railroad town" and caters chiefly to passengers from trains and to railroad shop and trainmen. Column (6) lists the amounts actually paid for the goods used at the restaurant during April, 1919. Column (5) shows what would have been paid for the same quantities of the same articles had they been purchased at the prices of April, 1916. The ratio of column (6) to column (5) indicates that wholesale prices of the foods on the list, weighted in the manner indicated, rose approximately 74 per cent during the three years ending April, 1919.

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*Harris and Benedict, *loc. cit.*, p. 205–219.

† The company has requested that its identity be not disclosed.

WHOLESALE PRICES OF THE PRINCIPAL PERISHABLE AND GROCERY SUPPLIES USED AT A RESTAURANT IN A "RAILROAD TOWN," APRIL, 1916, AND APRIL, 1919

Article	Unit	Price per unit		Amount used April, 1919	Amount used April, 1919, X price April, 1916	Amount used April, 1919, X price April, 1919
	(1)	April, 1916 (2)	April, 1919 (3)	(4)	(5)	(6)
		Dollars	*Dollars*	*Unit*	*Dollars*	*Dollars*
Grains and their products:						
Corn meal	Lb.	.02	.045	92	1.84	4.14
Crackers, oyster	“	.07	.16	74	5.18	11.84
Flour, hard white	Cwt.	2.70	5.00	46	124.20	230.00
Flour, soft white	“	2.82	4.95	26	73.32	128.70
Macaroni	Lb.	.05	.105	42	2.10	4.41
Oatmeal	Pkg.	.15	.255	46	6.90	11.73
Rice	Cwt.	5.45	10.50	1.05	5.72	11.02
Spaghetti	Lb.	.05	.105	68	3.40	7.14
Wafers	Pkg.	.114	.18	102	11.63	18.36
Sugar and related products:						
Sugar, granulated	Cwt.	5.66	9.00	19.9	112.63	179.10
Sugar, powdered	“	5.70	10.00	2.88	16.42	28.80
Sugar, N. C.	“	5.48	9.55	4.01	21.97	38.30
Sugar, C. L.	“	7.00	10.33	5.74	40.18	59.29
Syrup, Mayflower	Gal.	.73	1.30	32	23.36	41.60
Vegetables and truck:						
Fresh—						
Asparagus	Lb.	.08	.14	260	20.80	36.40
Beans, lima	“	.06	.134	73	4.38	9.78
Beans, navy	“	.055	.09	165	9.08	14.85
Beets	Doz. bchs.	.33	.34	18	5.94	6.12
Carrots	“ “	.385	.42	27	10.40	11.34
Cauliflower	Doz.	.90	1.16	12	10.80	13.92
Lettuce	“	.26	.465	133	34.58	61.84
Onions, old	Sack	1.66	3.68	7	11.62	25.76
Potatoes	“	1.94	2.57	62	120.28	159.34
Turnips	Doz. bchs.	.36	.29	21	7.56	6.09
Canned—						
Beans, string	3 lb. can	.10	.18	145	14.50	26.10
Corn	“ “ “	.086	.18	128	11.01	23.04
Peas, Early June	“ “ “	.092	.18	95	8.74	17.10
Fruits:						
Fresh—						
Apples, cooking	Box	1.24	2.08	29	35.96	60.32
Apples, table	“	1.94	3.67	15	29.10	55.05
Bananas	Lb.	.045	.077	509	22.90	39.19
Grapefruit	Box	2.80	2.63	17	47.60	44.71
Oranges	“	1.54	4.20	13	20.02	54.60
Strawberries	“	.07	.14	165	11.55	23.10
Canned—						
Apricots	Gal.	.27	.46	19	5.13	8.74
Blackberries	“	.314	.63	12	3.77	7.56
Peaches, pie	“	.27	.583	29	7.83	16.91
Pineapples	3 lb. can	.115	.21	104	11.96	21.84
Dried—						
Prunes	Lb.	.058	.17	75	4.35	12.75
Raisins	“	.107	.107	278	29.75	29.75
Poultry and dairy products:						
Butter, table	“	.315	.62	882	277.83	546.84
Cheese, American	“	.175	.26	106	18.55	27.56
Cream	Gal.	1.00	1.50	343	343.00	514.50
Eggs	Doz.	.218	.415	1749	381.28	725.84
Chickens	Lb.	.235	.44	620	145.70	272.80
Hens	“	.18	.36	499	89.82	179.64
Milk	Gal.	.20	.32	1847	369.40	591.04
Fish:						
Fish	Lb.	.06	.11	581	34.86	63.91

Article	Unit (1)	Price per unit		Amount used April, 1919 (4)	Amount used April, 1919, X price April, 1916 (5)	Amount used April, 1919, X price April, 1919 (6)
		April, 1916 (2)	April, 1919 (3)			
		Dollars	*Dollars*	*Unit*	*Dollars*	*Dollars*
Meats and fats:						
Bacon	Lb.	.22	.485	249	54.78	120.76
Beef butts	“	.14	.22	1847	258.58	406.34
Beef loins	“	.22	.44	484	106.48	212.96
Beef short ribs	“	.08	.15	259	20.72	38.85
Calf liver	Each	.20	.30	50	10.00	15.00
Frankfurters	Lb.	.12	.23	70	8.40	16.10
Ham	“	.17	.30	2092	355.64	627.60
Lamb racks	“	.18	.48	183	32.94	87.84
Lard	“	.11	.24	1188	130.68	285.12
Mutton legs	“	.09	.30	97	8.73	29.10
Pork loins	“	.155	.293	229	35.50	67.10
Sweetbreads	“	.16	.18	380	60.80	68.40
Veal hinds	Cwt.	13.46	28.00	3.33	44.82	93.24
Miscellaneous:						
Baking powder	Lb.	.22	.33	100	22.00	33.00
Catsup	Gal.	.65	.95	15	9.75	14.25
Coffee	Lb.	.265	.31	432	114.48	133.92
Oil, olive	Gal.	2.165	4.62	11	23.82	50.82
Salt, rock	Sack	.325	.65	28	9.10	18.20
Soap, laundry	Box	2.00	4.66	13	26.00	60.58
Vinegar	Gal.	.14	.31	34	4.76	10.54
Total					3,946.88	6,872.48

Ratio of total outlay in April, 1919 ($6,872.48), to total outlay in April, 1916 ($3,946.88) = 174.1 per cent.

Similar data have been prepared by the company for the periods shown in the following table:

Period	*Increase in prices*
June, 1914, to June, 1919	72.3 per cent
April, 1917, to April, 1919	39.5 “ “
June, 1918, to June, 1919	16.7 “ “

A comparison of these figures with the index for the period April, 1916, to April, 1919, would indicate that food prices did not rise from the middle of 1914 to the middle of 1916. From April, 1916, to April, 1917—the last year of our neutrality—prices increased much more rapidly than from April, 1917, to April, 1919—the two years following our entrance into the war.

Edmund E. Day.

TRANSFER OF THE REGISTRAR-GENERAL'S OFFICE

The whole administration of the Department of the Registrar-General of Births, Deaths, and Marriages, including the administration of the census of the population, has been transferred to the Ministry of Health. In April, 1918, the British Medical Association issued a pamphlet on the Ministry of Health, giving reasons for its establishment as one of the principal departments of state, and recommending this change. In this pamphlet it was pointed out that one of the main duties of a Ministry of Health would be the prosecution of scientific research by the analysis of statistics, among other means, and it was observed that the registrar-general's department could easily be transferred directly to the Ministry of Health.

At that time the registrar-general reported to the president of the Local Government Board, through which board responsibility to Parliament was maintained; but the registrar-general's office was practically an independent government department. The British Medical Association also stated that the information which the registrar-general's department was able to supply was essential to efficient health administration, both central and local, and suggested that the department, on its transfer to the Ministry of Health, should take over the preparation of certain statistics such as those furnished under the Act for the Notification of Infectious Diseases.

Dr. Addison has appointed Mr. S. P. Vivian, an assistant secretary in the Ministry of Health, to be Deputy Registrar-General of Births, Deaths, and Marriages.

L. I. D.

A CORRECTION

I wish to call the attention of the readers of the QUARTERLY to an error in one numeral in Table III of my article on "Is the New Immigration More Unskilled than the Old?" which appeared in the June, 1919, issue of the QUARTERLY. This table, which, as stated, was taken from Volume I, page 174, of the report of the United States Immigration Commission, gives the number of skilled laborers from Southwestern Europe from 1899–1909 inclusive, as 804,920 out of a total immigration from these countries of 5,939,252. Due to some unaccountable slip in copying, however, the percentage derived from these figures was listed as 16.6 when as a matter of fact it should of course have been 13.6. Because of a misunderstanding between the editors of the QUARTERLY, I was not furnished with the proof of the article and thus had no opportunity of rechecking the figures and catching the mistake.

I am exceedingly sorry that this error crept into the table. It does not, however, vitiate the conclusion drawn; namely, that there is no marked difference in the percentage of skilled workmen in the "new" as contrasted with the "old" immigration, when these terms are properly defined. With the corrected percentage, 13.6 per cent of the total immigrants from Southeastern Europe from 1899 to 1909 inclusive, were skilled, while only 11.4 per cent of the total immigration from Northwestern Europe for the period 1871–82 were skilled.

PAUL H. DOUGLAS.

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QUARTERLY PUBLICATION OF THE

AMERICAN STATISTICAL ASSOCIATION

COST OF PRODUCTION STATISTICS*

By Lewis H. Haney, *Bureau of Markets, Washington, D. C.*

THE ECONOMIC VS. THE ACCOUNTING CONCEPT OF COST

I. THE IMPORTANCE OF COST OF PRODUCTION STATISTICS

The importance of cost of production statistics is suggested by a mere reference to their use in connection with (1) price control, (2) taxation, (3) wage problems, (4) comparative efficiency studies, and (5) improvement of competitive conditions.

Cost of production statistics would make for *efficiency in production.* They would increase the possibility of comparative-efficiency studies, which would make the struggle for survival among different methods more intelligent. They would throw light on the vitally important question of relative efficiency of large and small scale business units. And in this connection, I would invite attention to the Federal Trade Commission's report on the cost of producing copper, in which (on page 18) it is made clear that the cost per pound varies almost inversely with the output.

I would especially call attention to the fact that cost of production statistics, if reasonably comprehensive, would be a step in the direction of encouraging *reasonable competition.* We hear much talk of reasonable restraint of trade; on the other hand, we know that there is cutthroat competition. This competition arises frequently from a lack of knowledge of cost. The collection of cost of production statistics would be invaluable as an education to the business men of the country. I think it may safely be said that if each and every producer knew his own true cost, competition would be revolutionized. Indeed, on the assumption which I have just made, it might safely be hoped that economic theory would go far toward fitting actual industrial facts, for ignorance has always stood in the way of the possibility of applying the economic theory.

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* Read before the eighty-first annual meeting of the American Statistical Association.

In addition to these more practical advantages, there is every reason to believe that economic and statistical theory would be greatly enriched and to some extent corrected by the collection of cost statistics. Such work as has been done thus far certainly whets the scientific appetite. I refer to the recently published cost studies of the Federal Trade Commission (coal, copper, etc.) and the report of the Tariff Commission on costs in the sugar industry. Such studies may enable us to answer conclusively such questions as: What scale of operations is most economical? Is large-scale operation ever profitable in agriculture? What proportion of total cost consists of "labor"? Is there any profit at the margin? The importance of presenting series of cost figures and of throwing light on dispersion, will be apparent.

Proceeding largely on the basis of my recollection of the data I observed when connected with the Federal Trade Commission, I will venture to say that in the case of such industries as copper, lumber, coal, sugar, and cement, the following points will be found to be true:

(1) Commonly, the costs of different plants vary widely, a range of as much as 100 per cent being frequent.

(2) If curves be plotted representing a series of company or plant costs, they will be found to have a rather uniform and regular, though somewhat asymmetrical shape, owing to the fact that a majority of the plants are grouped not far from the average cost, with relatively small groups of high-cost and low-cost companies at the extremes.

(3) Somewhat over half the output in any industry (of the class indicated), however, will come from companies whose costs are less than the average; but this does not mean that the larger plants or companies will have the lowest costs. Put in another way, the weighted average cost will be somewhat less than the simple average of company or plant costs, though not necessarily much less. It will also be lower than the median cost, but will sometimes be greater than the modal cost.

(4) The modal cost may be greater or less than the median cost in the series, depending to a considerable extent upon whether the number of relatively high-cost units (companies or plants) is great enough to pull up the median. (Monopolistic control, enabling inefficient producers to survive, is often indicated by a modal cost which is much lower than the median. It is interesting to note that this situation is indicated to exist in some of the industries investigated by the Federal Trade Commission, these often being pathological cases!)

(5) Ordinarily a considerable percentage of the output will be found to come from plants or companies whose total costs are higher than the

price of the product sold, perhaps between 10 per cent and 20 per cent of the total output coming from such extra-marginal concerns.

(6) There will generally be a sharp break upwards in the cost curve at this point, which will often correspond to the marginal point.

(7) A little lower on the cost curve, there will generally be a more gradual rise, commencing at a cost which will cover from 70 to 75 per cent of the total output. This point will often correspond to the modal cost.

The foregoing generalizations are illustrated by the following cost statistics taken from reports of the Federal Trade Commission:

NEWS PRINT PAPER COSTS, 1915

Cost Groups	No. of Mills	Produced (Tons)	Per Cent of Total	Avg. Cost per Ton
Less than $27	3	195,830	19.1	$26.64
$27 and less than $30	2	138,934	13.5	28.51
$30 and less than $33	8	260,505	25.4	31.64
$33 and less than $36	11	276,672	27.0	34.75
$36 and less than $40	8	120,199	11.7	37.74
$40 and over	3	33,321	3.3	43.67
Total	35	1,025,461	100.0	$32.21

Average cost .... $32.21 = 60% of output
Median .... 34.58 = 85% " "
Mode (est.) .... 35.17 = 85% " "
Range of costs: $25.77 to $44.41 per ton.
Average price = $38.45*

* Average net realization

COPPER COSTS, 1918

Cost Groups	No. of Companies	Production 1918	Per Cent of Total	Accumulated Per Cent
Cost less than 12 cents	2	122,245,051	5.41	5.41
Cost between 12 and 13 cents	4	208,571,191	9.24	14.65
Cost between 13 and 14 cents	4	314,553,177	13.93	28.58
Cost between 14 and 15 cents	4	359,617,743	15.92	44.50
Cost between 15 and 16 cents	2	98,307,293	4.35	48.85
Cost between 16 and 17 cents	8	460,528,645	20.39	69.24
Cost between 17 and 18 cents	9	255,399,696	11.32	80.56
Cost between 18 and 19 cents	3	72,373,388	3.20	83.76
Cost between 19 and 20 cents	5	28,491,436	1.26	85.06
Cost between 20 and 21 cents	5	36,871,193	1.63	86.65
Cost between 21 and 22 cents	9	135,538,602	6.00	92.65
Cost between 22 and 23 cents	3	60,861,465	2.70	95.34
Cost between 23 and 24 cents	5	44,919,772	1.99	97.32
Cost between 24 and 25 cents	1	6,230,694	.28	97.66
Cost between 25 and 26 cents	3	7,605,224	.34	97.90
Cost over 26 cents	18	46,119,555	2.04	100.05
Total all companies	85	2,258,234,125	100.00	....

Average cost .... 16.17 cents = 69% of output
Median (est.) .... 20 cents = 85% " "
Mode (est.) .... 17+ cents = 80% " "
Range of costs = about 10 cents to over 30 cents per pound.
Average price = 24.7 cents per pound.*

* Price fixed by the War Industries Board.

It will be observed that over 60 per cent of the output comes from companies or mills producing at costs under the weighted average, and that about 80 per cent of the output is covered by the modal cost. In comparing costs and prices, allowance for interest on investment may be made by remembering that the average investment per pound of copper was $0.30, so that 1.5 cents would yield 5 per cent. Also, that paper mills realized an average gross profit of $5.60 per ton from average net sales of $38.45,* which yielded about 6 per cent on the average investment; *i. e.*, $5 per ton would about yield 5 per cent on investment. At this rate, 16 out of 35 mills failed to make more than bare interest on investment, and 5 showed a positive loss.

II. THE NATURE OF COST, AND THE ESSENTIALS OF A STATISTICAL CONCEPT OF COST

There are almost as many ways of defining cost as there are different interests actuating men or groups of men in production. The greatest line of cleavage in defining costs, however, is that which lies between society and the individual.

Put in the most general terms, from the social point of view, cost is the measure of the obstacles to that human activity which is directed toward the gratification of human desires. It is thus a factor in determining motives and in directing activity in production, and it owes its significance in the last analysis to its power to motivate the producer. This definition of cost can be generalized, since it does not lead to duplications or to the inclusion of elements of surplus. It is not dependant upon price, but can be used in the analysis of price determination. It is in line with the conception of costs as composed of the pains and sacrifices of those engaged in production. But note that it is broader than "pain cost" in that it would include the exhaustion of natural resources. Robinson Crusoe on the desert island had to husband his scanty supply of powder; and with a nation, or a society, the facts that there is a limited supply of some raw material that is necessary to the life of that nation or society, and that this resource is being exhausted by production, become very significant: this condition acts as a sort of obstacle to the gratification of desires. In fact, the scope of cost becomes broadened as men's appreciation of the future becomes keener, as is illustrated by the fact that the conservation movement of today has become associated with a growing emphasis of "depletion" as an element in cost.

Individual costs differ from social costs. The end of mere individual human activity is largely, though not necessarily entirely, selfish, since it is generally concerned with the welfare of the individual and his immediate family circle or business unit. The obstacles to his activity are largely obstacles to his money-making, and his costs are generally counted as money costs. Again, from the mere individual point of view, the choice between two gains, one of which must be foregone, may seem to be an immediately motivating factor; and this has been called "opportunity cost." Also, because the individual necessarily takes a short-time point of view, it follows that he has but a very remote appreciation of the cost aspect of the exhaustion of natural resources.

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* The price of paper was low and rose rapidly from 1915 to 1916.

Costs considered from social and individual points of view may bring the same result, if the individual actions do not clash with social welfare. An obvious case occurs in the use of labor-saving devices. A cement company may desire to install boilers and flues for the purpose of saving waste heat and recovering potash, which will both reduce the owner's money-cost, and benefit the public.

But costs from the two points of view may also conflict. Social ends, as compared with individual ends, are broader in space and more distant in time. Also, the ultimate obstacles to human activity from the social point of view do not lie in things which prevent mere money-making, but in things which limit the net increase of articles of consumption. We need continually to heed the old reminder that money-making is not necessarily production. From the social point of view, the fact that limited supplies of coal, oil, or copper are being exhausted makes it essential that each ton, barrel, or pound be counted as cost; but to the individual mine-owner, it may seem quite unnecessary to "figure depletion." Or, the individual may seek to capitalize "opportunity" by charging some raw material which he owns into his "cost of production" at the market value, instead of at its actual cost. He may deceive the public and even himself as to his true net earnings, and thus prevent the full exploitation of that material which would be in the public interest. Such individualistic manipulations make costs either too little or too big from the social point of view, tending either to retarded production or to wasteful over-production. Moreover, such procedure defeats the very purpose of statistics, for the particular "opportunity," or appraised market-value, "costs," being hypothetical and estimated, cannot be counted as actual things, and if taken as estimates, are bound to result in hopeless duplication or in the inclusion of elements of surplus. They cannot be generalized.

In my judgment, an important problem in connection with cost of production statistics is so to define costs that statistics of cost will bring us correct results from a true social point of view. The true point of view must be one that, while recognizing the existence of individual interest, will seek to harmonize individual or class interests; one which, in other words, will combine the two points of view—one which can be generalized.

Another distinction which has to be drawn is that between *economic costs and accounting costs.*

The accountant, in his work, necessarily takes a rather individualistic point of view, for he is employed to "get results" for an individual business.

He is concerned with money costs. Costs, from the accountant's point of view, represent actual money paid out. They concern the administration of the operations of the business unit, and consist of payments made for the labor which may be hired, for material which must be purchased, and for such general expenditures as are incurred, including depreciation. When the business is forced to borrow money to meet some current obligation, or when it is forced to rent a piece of land or a building, the interest paid on the money borrowed, and the rent actually paid, are items of out-go which cannot be funded or capitalized, but must be met if the business is to continue. Such payments are therefore costs. It follows that accounting costs are tangible and of record. They can be counted. They do not, however, reveal true total payments for the several economic factors. The "labor" item as generally found on the books is merely the "pay-roll" and does not include either the administrative or managerial labor, or the "labor" tied up in purchased raw materials in non-integrated concerns, and in "materials and supplies" in all concerns. Moreover, the interest and rent items can truly include only the amounts paid out, which do not correspond to the economist's "shares"; and in accounts there is confusion between land and buildings, as is general in the business world.

The accountant deals with the relations between a particular owner and his particular business, accounts being designed for the purpose of exhibiting exactly this relation. It follows, therefore, that the accountant regards rent on the particular property owned, and interest on the particular investment as income, for they come in to the owner (his employer) from his property or business. He cannot consider all capital goods, nor account for the total interest share.

In fact, rent on property owned, interest on the investment, and profits, are inseparable in accounting. They cannot be regarded as out-go, and so are not costs to the accountant. There is always a financial purpose of enabling the owner to deduct from his particular income the necessary out-of-pocket payments, in order that he may ascertain what is his true net income. It is only when such income is ascertained that interest on investment and profits can be known.

Obviously, the sum of particular accounting costs does not correspond to the sum of economic costs. With books kept as at present, we cannot get even the true total labor expense for any given product, especially in case the production is non-integrated. Moreover, salaries are often either nominal, or represent a distribution of profit; and materials, raw and other, are charged at fluctuating market values. Interest does not represent the cost of the capitalist, but merely a contractual payment on sums borrowed; and estimated interest on investment is hopelessly mixed with profits, rent, and hypothesis.

It is to be noted that from the accountant's point of view, costs concern payments made by the *producer*, and not payments made by the *consumer*. It follows that from the accountant's point of view, cost cannot normally equal price, but will be somewhat less.

The economist's costs are somewhat different from accounting costs. He has to consider from the point of view of society the problem of the total supply of capital goods, and the direction of their use. His interest in any particular investment and the return thereon, is incidental. He is therefore concerned with interest as representing a social cost. Economic theory can and does separate rent, interest, and profits; for it is not concerned with the profit and loss sheet of a given business or of any particular property. To the economist as a student of normal competitive conditions, cost is not what the owner or operator pays out, but is the equivalent of what the consumer pays, and he considers it both from the point of view of the consumer and from the point of view of its effect upon production. Therefore, his cost must equal the price. Price, he regards as an expression of the forces tending to equilibrate demand and supply.

It should be observed that there is a small minority among both accountants and economists who are seeking to combine the two points of view and make accounting and economic costs identical. Among economists this minority consists of those who would recognize the so-called "opportunity cost" as a price-determining cost. A few accountants would treat interest on investment as operating cost. Although they have very diverse motives and interests, both of these groups assume an extremely individualistic point of view, and proceed upon the assumption that price determines cost. With both, the costs are not actual, but hypothetical. Both would disregard the interests of society in seeking to equalize the inefficient or the parasitical with the efficient and the socially productive.

In the reference already made to accounting costs, the distinction between the owner and the operator has been pointed out, and this distinction is essential if the various conditions which arise in dealing with accounting costs are to be understood. The owner stands for capital; the operator for enterprise, which is generally identified with the manager. Accordingly, the accounts which will satisfy the mere owner's interest are not at all those which would satisfy the operator. Owner accounts concern the relation between the owner and his property, and consist primarily of a balance sheet and an income account or profit and loss statement. Operator accounts show the relation between the operator or manager and the operation which he directs, and consist primarily of "cost sheets," which have their relation to the owner accounts in that they must be carried into the profit and loss statement, which in turn serves to connect the income account with the balance sheet. The owner's accounts center in profits, including interest on investment; the operator's accounts center in out-go costs, including wages, materials, and general expenses.

Closely parallel to the foregoing distinction is the distinction between "cost of sales" and "cost of production." By "cost of sales" is here meant cost in the sense of all deductions made from operating income, and such costs are reducible to a unit basis by using the quantity sold as a divisor. In getting the cost of sales, therefore, we have to consider the change in total value of inventories. To the operating man, the fact that the value of inventories decreases during a given period of time makes no difference, but to the owner, it may be of vital importance. In order to ascertain the profit or loss for the business, it is necessary that a net decrease in the total value of inventories be added to cost, and it is only thus that cost can, as the phrase runs, "tie into" the profit and loss account, and thus into the balance sheet. The quantity sold must be used as the divisor, for the owner is concerned, after all, not with what is produced, but with what is marketed; not directly with cost, but with total net income.

It should be noted, too, that the cost of sales is but a hypothetical cost, including as it does an estimated value of inventories, which being stock on hand has not been sold, and might, if actually put upon the market, bring a different price from that at which it is carried on the books.

Production cost, or output cost, as it might be called to distinguish it from cost of sales, does not consider inventories, but represents what it actually would cost at the present time to replace the stocks of product on hand. The divisor used is the quantity actually produced during the period of time under consideration, and the dividend is the sum of the operating expenses actually paid out or chargeable to the operation involved in the production of the quantity used as a divisor. It is production or output cost, as distinguished from cost of sales, with which the nation or society is interested, and which should be used for the purpose of regulating prices.

Another phase of the distinction between owner costs and operator costs is suggested by the terms "conversion" and "capital replacement." The owner is interested in capital replacement, but this is not true of the operator, as such. In accounting, conversion, or manufacturing cost, is the operating expense strictly construed, and consists of payments made by the operator for labor, materials, etc. It may include interest actually paid on money borrowed to meet current expense, but not interest on investment. Such conversion cost will include maintenance and repairs which are required to keep the plant and equipment going, but not depreciation which is over and above maintenance and repairs, and occurs in spite of them. Capital-replacement cost, on the other hand, concerns the charges necessarily made to return to the owner his property when it is worn out or exhausted, and may be divided into three heads, depreciation, extinguishment, depletion. The last two are less understood, and a word may be added concerning them. If a lumber mill buys timber land sufficient to enable it to operate for ten years, it constructs a railway for logging supplies, and a saw-mill, installing all equipment connected with these operations. It may build a town, and establish a commissary. The life of these items may be considerably longer than ten years. It therefore becomes proper and necessary for the lumber man to write off the cost of his plant over a period of ten years, and this is what is meant by extinguishment charges. Depletion is similar, but concerns the exhaustion of the raw material itself.

It will be observed that "capital replacement costs" do not exactly coincide with "owner costs" (as distinguished from operating costs), since they include wear and tear, which is an operating item. Also, although they bear some relation to cost of sales, in regarding inventories as an item of capital, the two costs are otherwise quite different.

With the foregoing distinctions in mind, we may say that in laying a basis for cost of production statistics:

1. We must proceed from a social point of view, which will consider as costs things which will actually motivate individuals, but which exclude factors that cannot be generalized, either because they tend to destroy society by motivating anti-social activities of individuals, or because they involve duplication (or negation).

2. We must secure data from accounts and accounting costs, but we must use them to portray economic facts. Ultimate economic costs

cannot be counted; we probably can never hope for very close statistical measurement of sacrifices, pains, or exhaustion of natural resources. Accounting costs are the only actual data available. (The so-called "entrepreneur costs," if they mean anything different from accounting costs, are unreal or even socially vicious, to say nothing of the duplications or negations that would result from an attempt to enumerate and total them.)

3. There are important limitations on accounting data which must be removed if true statistical results are to be gained. (a) Accounts cannot show us the total labor cost, to say nothing of interest, uninsurable hazards, and rent. (b) Accounts require much analysis to eliminate false items and duplication. (We cannot assume that errors will offset each other.) (c) Accounts probably will never show us the true total cost of any good, as they include a considerable element of goods and services taken in at market values. This may be especially difficult to deal with when a good is procured by a series of non-integrated concerns.

4. We will be interested primarily in cost of production, not of sales, as it is this which determines public policy and private activity in the long run.

5. We should include items from both owner and operator costs, taking in both conversion and capital-replacement charges. In this connection it is essential to secure accurate data on cost of investment.

The problem all the way through is to prevent the taking of interest and profits on any *particular* investment for granted, or in other words, to prevent giving out statistics which will tend to establish a guarantee of rates on any particular investment. Also, conversely, a second problem is to establish conditions based on statistical information which will help wise and honest investments to make a fair rate of return.

Concretely stated, the foregoing distinctions may be applied, and an approximation to the solution of the foregoing problems be reached, by making our costs include certain items which are sometimes not included, and excluding certain items which are often included. Some of the more important, according to my experience, are as follows:

Items to be included in cost:
- (1) Depreciation
- (2) Extinguishment
- (3) Depletion
- (4) Wages of managers and executives
- (5) Losses due to shrinkage, spoilage, etc.

Items to be excluded from cost:
- (1) Charges against income (excess profit taxes, interest on investment, etc.)

(2) Contingency reserves and uninsurable hazards
(3) Distribution of profits (excessive salaries)
(4) Inter-company profits and inter-departmental profits
(5) Capital charges
(6) Costs not properly connected with the given operation or time, ("outside operations," undue proportion of long-time charges)

Items required in addition to cost:

(1) Investment (actual expense and depreciation charged off in the past)
    (a) Reserves of raw materials (ore, oil, stumpage, etc.)
    (b) Land (factory and office sites)
    (c) Plant and equipment (buildings, machinery, etc.)
(2) Property used in addition (leased, etc.)
    (a), (b), (c), as above.

If we continue to use accounting costs, we should do so with a more intelligent appreciation of their limitations. In any case, we can forswear that hybrid monster which the economist calls "opportunity cost," and the accountant calls "interest on investment."

III. SOME PRACTICAL QUESTIONS CONNECTED WITH THE COLLECTION, COMPILATION, AND PRESENTATION OF COST OF PRODUCTION STATISTICS

How should cost-of-production statistics be collected? It would involve a very careful preliminary study of representative companies in each industry selected. As a result, a schedule, or schedules, would be prepared, and would be the basis for collecting the bulk of the data required. There would have to be a check with the books of representative companies, which makes it important that the body collecting the figures should have power by law to go to the books and records. I may say that my experience convinces me that even the best of cost schedules cannot be entirely satisfactory, and that questions are bound to arise which must be answered by correspondence, and in many cases, by scrutiny of the accounts. In this connection, it will be important at times to check the cost figures into the profit and loss account; and the schedule, to be satisfactory, must certainly call for a statement of the actual investment and depreciation, and such controlling figures as the quantity produced, quantity sold, the total expense, the addition to surplus, and the distribution of profit.

The scope of cost of production statistics would be an important matter to decide. The industries to be covered would be decided on the basis of their importance and the known difficulties of getting satisfactory results from them. It would be expedient to consider the advisability of going on with the work already done by the Federal Trade Commission and other bodies, covering such industries as coal, steel, oil, lumber, sugar, and copper. In not a few cases it will be found necessary to await accounting progress. In more than one industry of considerable magnitude, it will today be found virtually impossible to secure accurate cost data.

The areas, and the numbers of companies to be covered, may be various, and it will be found impossible to cover 100 per cent of the production in most if not all cases. The smallest companies, especially if it is assumed that these are the least efficient, may be omitted. The remaining companies may be grouped and graded, and a simpler schedule used for the smaller companies, with a more detailed one for the larger, for the latter generally have better accounts.

The frequency of reports is a matter of great importance, as the value of these figures, from a practical point of view, varies almost inversely with the time which elapses between the period covered and their presentation. On the other hand, the difficulty of securing current costs is enormous, for it may also be said that the correctness of cost figures varies almost inversely with the shortness of the period covered. Monthly or quarterly costs are bound to be rather unsatisfactory, inasmuch as certain items of expense have to be estimated and prorated. In some industries, like the production of rosin and turpentine, for example, where there is a seasonal cycle of production, it is doubtful if satisfactory figures can be secured for any period less than a year.

Perhaps the most interesting practical question is the consideration of the details with which the investigation would be concerned. In the first place, I will say that the costs should be analyzed into three great divisions, labor, materials, and expense. This is the most feasible distinction of public value that the accounts in general permit. Moreover, it has a practical advantage in the fact that most of the errors in cost statistics come in the item of "expense," and this segregation therefore would facilitate checking.

One great problem lies in the distinction between what we may call departmental costs and economic costs. Each department of a business, taking the material through various stages to the shipping stage, involves labor, materials and supplies, etc., and with the present accounting development, it probably would be impracticable to get these departmental costs satisfactorily. To give but one concrete reason, the item of "maintenance and repairs" is not available by departments in many industries. While costs by departments are extremely valuable to the manufacturer, it must be remembered that the total of departmental costs per unit will not check with the total cost of business, on account of the different quantities of material which pass through the different departments in any given period.

Two other suggestions: first, in handling joint costs, it would probably be wise at the outset to do no more than to attempt to get the average cost per unit of all the joint products combined, though it would be highly important to get the quantity and selling price for each product. Second, I would stress the importance of securing exact information as to the quantities produced, sold, and in inventory,—which, by the way, is a limiting factor, inasmuch as such figures are often much more difficult to secure than one would suppose.

In conclusion, I would point out that the amount of checking required is related to the degree of competition in the industry. It will be remembered that "costs" can be manufactured like any other product, and however optimistic we may be, we would be foolish to shut our eyes to the established fact that manipulation in costs is not only known to exist, but is known to exist frequently. Now, where we have monopoly, it is necessary to have compulsory access to books and returns must be carefully checked. Where we have limited competition a thorough check is necessary. Where, however, we have free competition—as is sometimes the case—we may accept the costs as reported by the company, with a great deal more assurance. However, considerable checking would be required, even here, as in matters of taxation, wage adjustments, etc., common motives would color men's treatment of cost, no matter how much competition there might be.

SUGGESTIONS AS TO THE LAWS OF CAPITAL RETURN UNDER CONDITIONS OF FREE COMPETITION*

By M. C. Rorty

In connection with the special interest that attaches, at the present time, to studies of costs of production and distribution, it is possible to suggest a complementary line of approach through the study of the actual rates of return on capital (including borrowed money) invested in productive and distributive enterprises. There is reason to believe that, in respect to such enterprises, operating under conditions of free competition, there are rather definite laws which govern the normal, or long period, distribution of the establishments and the invested capital by rates of capital return. The laws governing this distribution may be stated, tentatively, as follows:

1. Rates of capital return under conditions of free competition are determined not by the kind of production or distribution, but by certain constants, such as the ratio of invested capital to gross sales or output, the ratio of gross sales or output to the value added by manufacture or distribution, the relation of the business or industrial activity to the normal business cycle, *i. e.*, whether this activity fluctuates more widely or less widely than general business activity, etc.

2. In each particular line of production or distribution, prices are determined by the costs of operation of a group of establishments which earn, in the long run, only the rate of capital return reasonably necessary to maintain them.

3. In relation to this price-determining group of establishments, the entire investment in the industry, or distributive process, is arranged by rates of capital return in the form of a heavily skewed frequency curve, there being few establishments earning appreciably less than those of the price-determining group, but a very considerable number earning higher rates of return.

4. In industries or distributive processes where the rate of capital turn-over is high, where the ratio of value added by manufacture or distribution to the total value of output or sales is low, or where business activity fluctuates more widely than general business activity, the spread of the frequency curve is relatively great and the ratio of the average rate of capital return to the rate of capital return in the price-determining group is high.

The preceding suggestions as to the laws which govern capital return, and therefore prices, under conditions of free competition, cannot be looked upon as anything more than an indication of promising lines of investigation for the future. They have, however, been tested in a very limited way, through an analysis of the basic data used by Mr. J. E. Sterrett in the preparation of his article in "The American Economic Review" for March, 1916, from which data it has been possible to eliminate all figures for establishments not definitely known to be subject to active competition.

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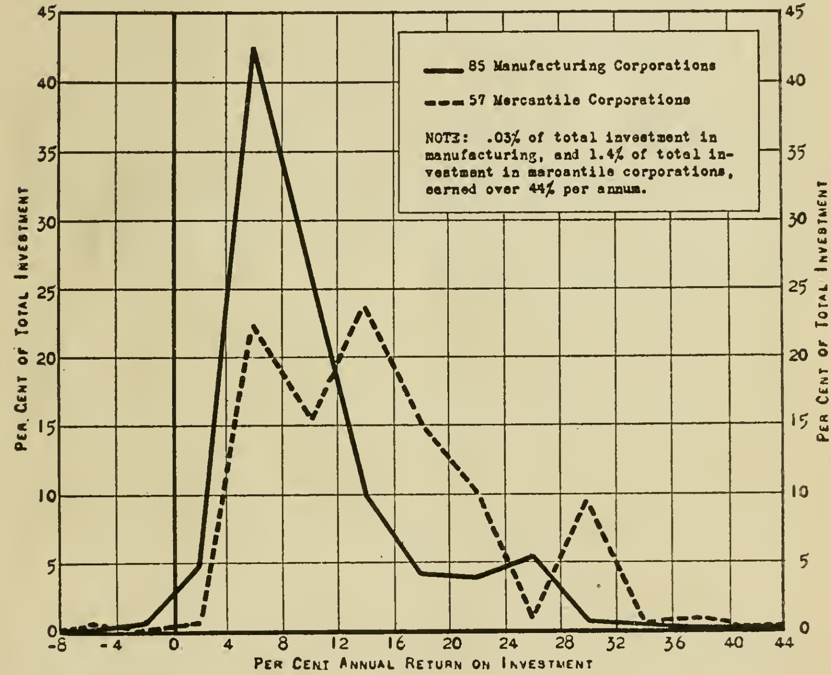
* Read before the eighty-first annual meeting of the American Statistical Association.

The accompanying curves indicate the results of this analysis and, so far as they go, bear out the assumptions previously made. The difference in the spread of the curves for manufacturing and mercantile establishments is particularly noticeable. It is hardly to be accounted for by accidental variations due to the small number of establishments considered, and may be assumed to be due mainly to the fact that the capital turn-over in manufacturing ordinarily does not exceed 200

FREQUENCY DISTRIBUTION OF AGGREGATE INVESTMENT

BY PER CENT ANNUAL RETURN ON INVESTMENT

(BASED UPON AUDITED RETURNS FOR ONE OR MORE PRE-WAR YEARS, GENERALLY THE YEAR, 1913. INVESTMENT INCLUDES BORROWED MONEY. 4 PER CENT FREQUENCY INTERVAL.)



per cent per annum, whereas this turn-over probably averages from 300 per cent to 400 per cent per annum in most mercantile businesses.

In connection with statistical studies of the kind under discussion, it is hardly necessary to indicate possible applications to questions of profit sharing, wage and price relations, excess profits taxes, and the basic distribution of national income. Regarding some of these questions, however, there is danger that entirely misleading conclusions may be arrived at, unless proper consideration is given to the fact that the general distribution of establishments by rates of capital return may remain relatively fixed, while at the same time individual establishments may make substantial profits one year and sustain substantial losses the next.

A further consideration, frequently overlooked, is that of the losses of capital in unsuccessful ventures. Some of those who have studied this question most closely are inclined to believe that the excess of the average capital return over a normal interest rate in established businesses would be wholly offset if the losses in legitimate, but unsuccessful, new ventures, and in the earlier lean years of successful ventures, could be, and were, capitalized. It is difficult to check this opinion statistically, but a rather extensive inquiry among stock brokers fails to reveal any real conviction among them that an investor who spreads his risks over a list of new ventures, selected even with somewhat more than ordinary care, will secure a better rate of return in the long run than by buying seasoned securities.

THE IMPROVEMENT OF CRIMINAL STATISTICS IN THE UNITED STATES*

By Louis N. Robinson, *Municipal Court of Philadelphia*

The beginnings of the Science of Criminal Statistics may be traced back to the year 1829. In that year, Guerry, whom Von Mayr regards as the founder of Moral Statistics,† published a small pamphlet on criminal statistics. On July 9, 1831, Quetelet delivered before the Royal Academy of Brussels his address, "Recherches sur le penchant au crime aux différens âges." With the further publication by Guerry in 1833 of his "Essai sur la statistique morale de la France," the science of criminal statistics may be said to have been fully launched.

In this country, New York state has the honor of being the first government unit of any size to collect data on which statistical studies of crimes and criminals might be based. In the same year that Guerry published his pamphlet on criminal statistics, that is, in 1829, it was made the duty of the clerks of courts of record to enter judgment of any conviction in their minutes and to send to the secretary of state a transcript of these entries ten days after the adjournment of such court.‡ Such material, it was thought, would furnish valuable evidence of the former convictions of old offenders. In the first report of the Secretary of State on this material, appearing in 1838 and covering the period 1830 to 1837, we find frequent references to Quetelet's book, *Physique sociale, un essai sur le développement des facultés de l'homme*, which had in the meantime been published. The connection, therefore, between the beginnings of criminal statistics on the continent of Europe and in this country is close. Massachusetts and Maine were the next states to collect statistical information on crimes and criminals, and this practice, of compiling data taken from the records of the courts themselves, or from material in the hands of district attorneys or similar officials, soon spread to other states.

Not content with the collection of judicial criminal statistics, two states, Massachusetts first and New York second, in 1834 and 1839 respectively, determined to obtain from those into whose custody prisoners were placed, *i. e.*, the keepers and the sheriffs, certain data somewhat analogous to that obtained from the courts and the court officials. In my book the *History and Organization of Criminal Statistics in the United States*, I have termed statistics of this kind "prison criminal statistics" in order to differentiate between the two sources of statistics of crime and criminals.

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* Read before the eighty-first annual meeting of the American Statistical Association.
† *Statistik und Gesellschaftslehre* (1895), vol. 1, p. 185.
‡ Robinson, Louis N., *Criminal Statistics in the United States*, p. 46.

The establishment of state boards of charities and correction and of state boards of control has given a further impetus to the collection of both judicial and criminal statistics, and the recent movement to create state departments of public welfare may be expected to further the development of each form of criminal statistics.

Turning now to the efforts to obtain criminal statistics for the country as a whole, we find that it was not until the census of 1850, twenty-one years after New York had begun the task, that the Federal Government became sufficiently interested to collect information of this character, and even then it was done only in a meager and half-hearted way. In fact it was not until 1880, when Mr. Frederick H. Wines was placed in charge of the division of Social Statistics relating to pauperism and crime that a genuine attempt was made to give to the public a statistical picture of our criminal population. Again in 1890, Mr. Wines was placed in charge of this work, and the plan of 1880, with some slight modification, was carried out. Owing to the fact that the work of the decennial enumeration in 1900 was limited to the inquiries relating to population, mortality, agriculture, and manufactures, the collection of criminal statistics by the Bureau of the Census was not made again until 1904.

Although Mr. Wines had planned in 1880 to compile facts obtainable from court dockets, he seemed to have met with little success, and the effort was not repeated by the census officials until 1907. This attempt also proved a failure, and we must, therefore, confess to the world that as a nation we have not yet been able to do more than to collect what I have termed prison criminal statistics, and these only at long intervals.

In 1904, a change in the policy of collecting the prison criminal statistics was made. In 1880, and again in 1890, the statistics dealt with those in prisons on a certain day of the year, but in 1904 the emphasis was placed on those who had been committed during the year, a practice which was followed in the enumeration of 1910 and which all statisticians today will agree ought to have been inaugurated at the beginning.

In 1911, I stated that the criminal statistics which were put out by state governments were, almost without exception, poor, and I have seen little reason to change my opinion of their character since that time. The best criminal statistics we have are those published by the Federal Bureau of the Census, and these are far from satisfactory for two reasons: first, because they appear at such long intervals, and secondly, because they are based on data obtained from institutions and not from records of the courts and are, therefore, very incomplete, since they do not include those whose punishment is other than commitment. For example, the total number of juvenile offenders committed to juvenile reformatories during the year 1910, is given in the *Report of the Bureau of the Census* as 14,197.* During the calendar year 1919, 1,242 juvenile offenders were placed on probation by the Municipal Court of Philadelphia alone, a little more than one-twelfth of the total number committed in the United States to juvenile institutions during the calendar year 1910, and more than any one of the forty-eight states, with the exception of New York, committed during that year.

From the summary which I have given of the history of criminal statistics in the United States, it is evident that the beginnings of criminal statistics in Europe antedated by only a few years the beginnings in this country. We cannot, therefore, attribute our poor showing to the newness of the venture. I am not concerned in this paper with an enumeration of our excuses, although it is true that an examination of a few of them will have to be made rather carefully in planning for the future.

Before taking up the problem of improving our criminal statistics, I feel that we should ask ourselves whether this effort is worth while. We know that all the principal European countries have for many years published excellent reports on criminal statistics and have seemed to feel that the work was well worth doing. I, for my part, feel that in the recent report of the Bureau of the Census we can find good reason for continuing the collection of these statistics, incomplete as they are, if we can do no better. I find, for example, that "Of the 493,934 prisoners and juvenile delinquents committed to penal or reformatory institutions in 1910, 278,914, or 56.5 per cent, were committed for non-payment of fine."† That fact alone is sufficient to justify the whole inquiry, since it throws into sharp relief what many of us have long contended, that the poor in this land do not get a square deal from the courts. Let me quote another statement from the same report: "Of the total number of commitments in the year 1910, 170,977, representing 34.6 per cent, or more than one-third, were for drunkenness; 91,928, representing 18.6 per cent, or almost one-fifth, were for disorderly conduct; and 50,302, or 10.2 per cent, were for vagrancy."‡ Together these three crimes account for 63.4 per cent of the total number committed. Even this partial picture, a 63.4 per cent picture, of our criminal class in so far as it is represented by commitments is, in my opinion, a good and sufficient excuse for the time and money spent on getting together the facts. I fully recognize, too, the importance of the studies of individual delinquents made by Healy and others. Their usefulness cannot be exaggerated; but on the other hand they do not constitute a substitute for criminal statistics. Like the work of Le Play, these studies give us information that criminal statistics cannot offer; but it can also be said that criminal statistics afford us information equally valuable, which studies of individual delinquents cannot in the nature of things yield to us.

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* "Prisoners and Juvenile Delinquents, 1910," p. 158.
† "Prisoners and Juvenile Delinquents in the United States, 1910," *loc. cit.*, p. 41.
‡ *Ibid.*, p. 30.

No student of criminal statistics will be content ultimately with anything less than the collection each year by the Bureau of the Census, of judicial criminal statistics, that is, of statistics made up of data obtained from court records for the country as a whole. I have already pointed out that the prison criminal statistics which the federal government now collects are very incomplete, and with the growth of probation and the development of yet other forms of treatment not of an institutional type these statistics must become still less reliable as a statement of our budget of crimes and criminals. Each one of the years of this new century has seen vast and far-reaching changes in our social system, and we should not have to wait for ten years to find out what these have meant in the way of increasing or decreasing crimes, or altering the composition of our criminal population. I shall look at the problem, therefore, with regard to the ways in which the federal government may secure better judicial criminal statistics.

Let us now return to the plan which the Bureau of the Census inaugurated in 1907. It was decided, I believe, at the outset to limit the scope of the work to certain states and counties. Special agents or clerks were sent into the territory selected and were instructed to copy on individual schedules from court records certain facts regarding each and every criminal handled by the courts during the calendar year 1906. I am sorry that I am unable to give the story of this attempt. It is well known, however, that it failed and that no report containing the facts thus collected ever appeared. Some weeks ago, I made a careful study of all court records, such as the special agents would have consulted in Philadelphia, and I was interested to learn that there is no record of any kind which would yield the social facts relating to the accused individual, questions 16 to 23 inclusive, which were called for on the individual schedule. Neither the transcript from the office of the magistrate, nor the bill of indictment; neither the judge's docket nor the minute book of the clerk, contained any information which would have aided the special agent to fill out his schedule. It would appear, therefore, that one reason for the failure of this inquiry of 1907 was the absence of a large part of the data called for, and one deduction which can easily be made is that to have secured any success whatsoever, so far as Philadelphia statistics were concerned, the individual schedules should have been in the hands of the clerks of court, or some other official selected for the task, at the beginning of the year 1906. Possibly by paying a small sum for each case, they could have been induced to fill in the schedule as the business of the courts progressed.

I wish now to call attention to the records which are kept by some of our juvenile courts and by other courts of like procedure. Juvenile courts took over from private philanthropic agencies the idea of a face-sheet. There had grown up in private agencies the practice of placing on the first or face-sheet of each case record the relatively permanent facts concerning the case in question. Often attempts have been made to take off data from these face-sheets and to tabulate the facts for statistical purposes. Usually, the compilations have not been such as to merit much approval from statisticians, due perhaps to a lack of discrimination in the selection of facts found on the face-sheets, and to an absence of statistical training on the part of those who devised the face-sheets and also on the part of those who filled them out. An analysis of the average face-sheet reveals the fact that it contains information of three kinds: that necessary (a) for identification; (b) for handling or treating the case; and (c) that which may be considered as truly statistical in character. Failure to recognize these three purposes in a face-sheet has led first of all to an inaccurate formulation of the statistical questions, which should, of course, be made to harmonize both in form and in content with similar questions asked on the population schedule by the Bureau of the Census; secondly, it has led to the compiling of all the facts on the face-sheets, many of which have no scientific statistical value whatsoever. In the Municipal Court of Philadelphia we are now engaged in revising all our face-sheets. We are taking particular pains to have on the face-sheets the same questions which are found on the population schedule, and are printing instructions which will insure that the answers will be given in the same way. We intend to set up in our own court a system of record keeping which will yield all the information that is needed as a foundation for criminal statistics.

I maintain that before the records of our criminal courts are filed away in the burying ground of the Clerks of Quarter Sessions or similar officials, there should be something in the nature of a face-sheet attached either to the bill of indictment or to the record of the procedure before the court as a basis for criminal statistics. If this were done, special agents could be sent around at regular intervals to copy the information. Otherwise, it can be obtained only by placing the schedules, as I have already suggested, in the hands of court clerks at the beginning of each year, or at the beginning of the year selected, and paying them for filling these out. The difficulty in this scheme is that if the clerk does not fill out the schedule when the accused is before him, he never will or can do it, since there is no record from which he can obtain this information afterwards. The Pennsylvania State Board of Public Charities makes no attempt to secure any social data from prothonotaries regarding the accused, from which I infer that court records throughout the state are similar to those which I found in Philadelphia.

Had time and leisure permitted, I should have liked to determine whether the records that are kept by the courts in other states are similar to those which I have observed in Philadelphia. My knowledge is too limited to enable me to suggest a complete plan for improving the criminal statistics of this country, and I must, therefore, content myself with making the following suggestions to the Bureau of the Census:

1. That the Bureau of the Census be requested to appoint either for full or part time a special agent whose duties shall be:

(a) To visit the various state boards or state officials charged with the collection of either prison or judicial statistics, and to ascertain the problems with which they are confronted in carrying on this work.

(b) To visit the offices of district attorneys, clerks of court, institutions, etc., and to examine their systems of record keeping with a view both to noting the facts therein contained and also to devising more adequate systems.

2. That the Bureau of the Census prepare a brief study of the jurisdiction of the courts in each state and keep the same up to date.

3. That on the basis of the report of the special agent and the study of the jurisdiction of the courts, a plan for the further improvement of criminal statistics be formulated, and the aid of such organizations as the American Institute of Criminal Law and Criminology and the Statistical Association be requested in putting the plan into effect.

No paper plan will succeed. Foundation work such as I have suggested will have to be undertaken. Surely, too, we have a right to look to the Bureau of the Census for the long persistent effort which will be needed to make criminal statistics a reality in the United States. Central guidance is also necessary, if there is not to develop such differences of practice by state boards and state officials as will render the task of whipping the statistics of the various states into a unified whole impossible. Many persons will say that the differences already found in the states regarding penalties and definitions of crimes make the task unthinkable; but these differences have not prevented the collection of fairly good prison criminal statistics and they should not prove to be insurmountable obstacles in the collection of judicial criminal statistics.

Finally, let me say a word to statisticians. Most scientists are Prussians at heart, having as their goal a system of government wherein they will be fixed as bright and immovable stars. In a democracy, however, scientists must fight for their position and for their opinions as vigorously as the veriest ward politicians, and the sooner they realize this, the sooner will science exercise some influence in our government.

THE CONCEPTION OF STATISTICS AS A TECHNIQUE*

By John Cummings, *Federal Board for Vocational Education*

It seems significant that with few exceptions, those economists who were summoned to Washington during the war period to give counsel and aid in mobilizing our resources for war purposes, worked in the government offices not as economists but as statisticians, and that the services which they organized were officially designated statistical.

Under pressure of the war emergency each newly established war board or council or commission, which engaged actively in mobilization work, proceeded to build up more or less independently of existing services, and at the outset more or less independently of one another, a statistical service of its own. Schedules fluttered out from these offices, and descended in smothering snow-like masses over the whole community, one heavy fall being piled upon another, each federal office functioning as a statistical storm center. In a comparatively short period one office alone sent out over 400 different schedules.

Theories regarding economic conditions and phenomena were for the time being at a discount, and overnight the demand for data became overwhelming. In response to this demand schedule inquiries were instituted regarding stocks of materials, stores of commodities, equipment for war work, number of laborers of different skills, industrial consumption of specific materials, housing conditions, and in general regarding our available material resources.

Government offices, it may be noted, were at the outbreak of the war filled with statistical clerks, statistical technicians, machine operators, expert card punchers, sorters, and counters; and while these technicians with all their paraphernalia were obviously not as a class competent to undertake the statistical enterprises involved in mobilization for war, it is nevertheless probably true that the capacity of the permanent statistical service of the government to undertake the work which had to be done was somewhat underestimated. Some lost motion, confusion, and duplication, some experimenting by those unfamiliar with official statistical practice, and it must be added unfamiliar with available official statistics, might perhaps have been avoided, if the government had proceeded more generally to develop its statistical service from within. Experienced statisticians were, of course, not available either in the government service or in any other service in sufficient numbers to undertake and carry on effectively all of the emergency statistical work which had to be done under pressure, but the policy of expanding existing services might nevertheless, it would seem, have been advantageously adopted more generally than it was, in preference to the policy of building up independent, uncoördinated, temporary services.

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* Read before the eighty-first annual meeting of the American Statistical Association.

One unfortunate consequence of the policy adopted has been the sudden collapse of important statistical enterprises initiated during the war, some of which at least might well have been continued during the reconstruction period, if not permanently. On the whole, the process of statistical demobilization is proving to be nearly as disrupting as was the process of mobilization, and it is being found difficult now to provide for the practical utilization and even for the permanent custodial preservation of statistical war records produced by temporary services which have been or are being disbanded.

But the point of special significance is that practically every inquiry proposed by the government during the war required a statistical answer, and it may be noted incidentally that the science of statistics in fact had its origin in the effort to supply governments with an accurate valuation of resources for waging war. If a statistician may be permitted to say so the simple fact is that economists who engaged in war work seemed to become for the time being statisticians; and economics to become for the time being statistics. Under stress of the war emergency it put away traditional hypotheses, personal philosophies, ethical speculations, and abstract theories, and went out into the hedges and byways to find out things by way of rendering real social service.

Now a quite similar sort of service is just as essential in peace time as in war time. In peace time, as well as in war time, we must mobilize our resources for the achievement of social ends. We must be continuously mobilizing for peace with the end in view to insure in the highest degree our social wellbeing, and in mobilizing for peace, as in mobilizing for war, the inquiries proposed by the government and by agencies of social amelioration are generally inquiries requiring statistical answers.

Under normal peace-time conditions, it may be noted, the work being done by those classified in the government service as economists is, as it has been during the war emergency period, very largely statistical. Official economists are regularly engaged in the conduct of extensive and intensive statistical researches, gathering data by the use of schedules.

Are, then, economists so engaged only undertaking to help out in a field of scientific research which is admittedly short-handed, or is this sort of service strictly economic?

Not infrequently statisticians themselves express the opinion that statistics is in fact not really a science at all. It is, as they conceive it, merely a method, and the statistician is merely a technician who may hire out to do statistical chores in any field indifferently. The economist may of course in any emergency, such as the occurrence of war, do his own statistical chores, but it seems to be assumed that he will perhaps generally prefer to hire them done for him. So of the sociologist and of all other scientific workers, it is assumed that they will each and all on occasion probably want to employ statisticians to do compilation work under direction. In the field of scientific research, it would seem that the statistician cannot operate independently on his own. He must hire out to somebody.

Is then statistics merely a void technique or, if one will, a void formal science on the one hand,—or does the technique or science of statistics embrace a content of data? In the one case the statistician is professionally interested and skilled in the technique and theory of compilation only, and in the other he is professionally interested primarily in the substance, interpretation, and significance of his compilations.

By common usage there would seem to be at least four fairly well differentiated or differentiable concepts as to what statistics are, or what it, if we use the term in the singular, is:

1. Statistics are compiled numerical data of all sorts.
2. Statistics is a method or technique of compiling numerical data of all sorts.
3. Statistics is a formal science of the method or technique of compiling numerical data of all sorts.
4. Statistics is a social science, with a method or technique of its own, a defined field of operation, and a cumulative fund of systematized data or knowledge relating specifically to social conditions and phenomena.

The first of these concepts identifies statistics with figures and tables and that sort of thing indifferently in any field. It is a world-almanac concept. The second and third concepts give to statistics, as a method or technique or science of compilation, a free range in the field of scientific research, but they do not comprehend the data upon which the statistician operates professionally in compiling them into tables. It is not the world-almanac itself, but the method or technique or science of compiling almanacs, that is here proposed as the subject of statistical interest and labor. The fourth concept comprehends the data with the method or technique of compilation, but restricts the range of professionally statistical research to social conditions and phenomena, which is traditionally the special field or preserve of statistical inquiry.

One may perhaps assume that the world-almanac idea of what statistics are will not satisfy the statistician's sophisticated sense as a definition of his profession, and that he will not write himself down as a mere compiler of the odds and ends of numerical data without rhyme or reason. He will not resign every source of inspiration for work. If he does not pretend to the lofty ideals of a professed science, he will at least pretend to the humble skill of an artisan who has mastered the simple technique of a lowly craft.

Passing on then to the second concept, obviously we cannot say "statistics or statistical data are a method or technique," and when we say "statistics is a method or technique," we clearly oust the data of statistics entirely from our concept, and imply that this mode or art of compilation, separate and distinct from the data compiled, is what we mean by statistics. If we did not mean this we should say, "statistics has—not is—a method or technique."

In this sense statistics is a way or manner or process of doing something. Probably in general what is implied is that it is a way of compiling numerical data, and specifically one way of doing, for example, economics or sociology or politics or biology or astronomy. That is to say, the statistical way of doing each and all of these sciences —one of several ways of doing each of them.

Statistics and statisticians are conceived to be in the service particularly of the social sciences. Statisticians may of course render service also in the biological and the physical sciences, but primarily and properly they ply their skilled trade of compiling data in the social sciences, because these sciences more than any other are dependent upon statistical compilations for the establishment of their basic hypotheses, and for the final verification of their speculative conclusions—or it may be in specific cases, as it has been frequently, for the disestablishment of fictitious hypotheses, and the demolition of false conclusions. In this humble capacity the statistician under close supervision fetches ballast of data for the social sciences, which are naturally speculative and naturally tend to rise into the ethereal regions where the danger of sudden burstings and rapid descents becomes imminent.

Thus the venerable mother of all the social sciences,—for statistics is the mother of the social sciences—is degraded to the position of a menial servant.

Mere compilation of data is in itself, when divorced from the function of interpretation, a very elementary sort of mathematics,—mostly addition and subtraction,—and the technique of compilation, also, is simple and easily mastered. Far less mathematics and technique is required for skilled compilation of data than is required, for example, by the machinist in many branches of his trade. If the statistician's job is compilation of data of any sort for any one, he is not a very high grade or very skilled artisan, and he clearly cannot rank in the fellowship of economists or politicists or sociologists, except as a sort of handy-boy in the splendid halls and palaces of the social sciences.

This conception of the statistician as a technician is quite consistent, it must be conceded, not only with the idea of purely technical service throughout the broad field of scientific research, but also with the idea which has been in times past rather prevalent in government offices engaged in statistical work. Not uncommonly those administering these offices have felt that a college education, for example, was quite superfluous for a statistician. As they conceived him the statistician was a technician, expert in working out tabulation fields for punching cards, expert in manipulating various types of punching, sorting, tabulating, and calculating machines, expert in reading his own tables into text, and in filling in blanks in standardized texts, preserved inviolate from decade to decade, or from year to year.

For this sort of work, essential as it is, a college education or any very protracted apprenticeship does indeed seem superfluous.

If now the statistician rejects this humble rôle of skilled artisan working under direction, if he pretends to something more than mere expertness as a technician,—if, in a word, he pretends to a separate and distinct science, is the subject matter of that science the method, technique, and mathematics of compilation, including of course, the mathematical determination of correlations, margins of error, interpolations, probable deviations, dispersions, and miscellaneous averages, indices, and rates?

There is here at least something that has altogether the aspect of being scientific, and any one who reads our own and foreign statistical journals, and the various systematic treatises dealing with the mathematical processes of statistical work, will concede that the statistician must, if he is to understand some of the literature of his science, be a fairly good mathematician. Unquestionably he must be able to use, if not himself to develop, mathematical formulas to the extent that may be required in the particular line of statistical work in which he is engaged, and this may mean very considerable expertness as a mathematician.

Mathematics is a universal language in which science expresses itself wherever this language is required to give precision to scientific statements, and the statistician uses this language as he has occasion to use it, just as every other scientific worker uses it, that is to say, as a language for giving precise expression to the conclusions of statistical research. But in and of itself the purely formal science of statistical compilation and interpretation is applied mathematics, and those who devote themselves entirely to it are essentially mathematicians rather than statisticians.

Practical statisticians know, moreover, that however interesting the mathematical manipulation of data may be in itself as mathematics, data in the raw mass as they come to the statistician are not generally susceptible of any considerable amount of mathematical refinement. Over-refinement of data is professionally recognized as a statistical vice, since it implies accuracy and simplicity in data to a degree which is unwarranted.

Defined as a formal science without specific content of data, statistics seems in fact to assume by definition a rather fictitious character. In the first place, the statistician is made to profess a science which does not comprehend the substance and data of his compilations, and, it may even be said, of his natural professional interests. Secondly, this science of compilation is not really his but the mathematician's, and in it the mathematician is professionally much more expert than the statistician himself. Finally, in the common mine-run of practical statistical work, this science of compilation even in very important lines of statistical research is in itself a poor thing, mostly addition and subtraction, and is not, except in some of its rather ornamental and attenuated refinements as a differentiated branch of mathematics, of a character which justifies its designation as a separate science.

As a professed master of this quite diminutive and ignoble science, it is true again that the statistician may sell his services in the open market to do compilation work in any field, but the chances are that his pretensions to a defined science will not be generally recognized as valid. As a compiler of data for the biologist, he will be for all his professions accepted as merely an artisan, practicing the simple technique of his trade in the field of biology. Probably, if the biological data require any considerable amount of mathematical refinement, the biologist will employ not a statistician but a mathematician. And he will be quite right in doing so.

It is to be noted that the statistician entering any foreign field,—that is to say, any field outside the range of social phenomena,—can carry with him only a very simple technique and rather elementary rules of procedure. He may take with him also the paraphernalia of his trade, card punching, sorting, tabulating devices, adding machines, slide rules, and calculating machines. This he does in his character as an artisan working with a more or less elaborate kit of tools and some degree of technical skill.

It will be freely admitted by statisticians that occasionally the statistician himself, for the precise interpretation of his data, must seek aid of the mathematician, who understands better than the statistician commonly does the harmonics and intricacies of mathematical calculations. And clearly the statistician who does seek such help must be presumed to be interested professionally in the substance and data of his compilations. Otherwise he will be in the position of employing a mathematician to render precisely that service which he himself professes to render, and his pretense to a science will become perfectly transparent and hypocritical.

What then is the statistician professionally interested in? The answer is that his interests lie clearly in the field of social phenomena. In this field statistics as a science originated in the service of princes and principalities; in this field it has rendered continuous service during the past centuries; and in this field it is today rendering service, extending the scope of its researches to embrace every phase of social life, direction, and conduct. This is the traditional field occupied by statistics down through the ages from its remotest origins as an administrative political science, the science of things worth knowing about the state, and developed in subsequent periods as the science of the *Goettliche ordnung* of human affairs, the *Physique Sociale* of Quetelet, the *Political Arithmetic* of Petty, and, finally, as the rounded out science of quantitative valuation of social phenomena.

The term science defines itself. It is knowledge, or as the dictionary puts it, "knowledge of principles or facts; accumulated and accepted knowledge which has been systematized and formulated with reference to the discovery of general truths or the operation of general laws; knowledge classified and made available in work, life, or the search for truth; comprehensive, profound, or philosophical knowledge."

Could any statistician devise a definition which would more certainly embrace in all of its aspects the accumulated and accumulating fund of compiled statistical data relating to social phenomena? Here certainly is a fund of "accumulated and accepted knowledge which has been systematized and formulated with reference to the discovery of general truths or the operation of general laws; knowledge classified, and made available in work, life, or the search for truth"—and the statistician may well emphasize in this definition the word "life." Statistics is knowledge systematized and made available for *life*, not primarily as raw material for the development of some other science, social or natural.

One essential characteristic of any true science is such a fund of established, universally accepted truths, representing in the mass the actual achievement to date of scientific workers in the given field. Statistics as a social science has this prime characteristic of a true science in a preëminent degree, far surpassing every other social science in this respect of an accumulating fund of systematized knowledge.

"A science," according to Jevons, "teaches us to know, and an art to do, and all the more perfect sciences lead to the creation of corresponding useful arts." Does statistics lead to any useful art or arts?

There is, of course, an art of compiling data, and this art may be conceived to have its origin in the science of statistics; but the art of compiling data is one of the most insignificant of the arts to which statistics leads.

Perhaps the supreme art mothered by statistics is the art of government. One must, however, add to this supreme statistical art all the specialized arts of social conduct, and amelioration—such as those occupied with philanthropy, social hygiene, and education. Not that statistics is the only science back of these several arts of social direction, conduct, and amelioration, but it is traditionally and essentially the primal science of these arts.

Legislation, philanthropy, and every program of social amelioration must take account of actual conditions and tendencies as collective aggregates, and statistics must provide the essential data for every such program, because the collective mass tendencies in social life cannot be uncovered except as they are given statistical measurement, statement, and valuation. Statistics as a social science stands this test of fostering useful arts also excellently well.

Statisticians accept freely the idea of service, and of service especially in the field of the social sciences. They must insist, however, that they render this service not as servants but as masters,—not as either servants or masters of economists or sociologists, but as masters of their own independent procedure and selection in the field of social research. The economist may properly present certain of his problems to the statistician for solution; as may also the statesman, or the expert in social hygiene, or the philanthropist. The prohibitionist may submit to the statistician the problem of determining certain of the social effects of drinking and of prohibition, and the Life Extension Institute may submit its problems. But the ultimate source of the statistician's problems is not economic science, or sociology, or the league to extend prohibition, or an institute to extend life itself, or any program of social amelioration. The ultimate source of the statistician's problems is the living, growing, changing, complex thing which we call society.

Historically, economics, politics, and sociology have been defined within the field of statistical research as originally conceived. Social sciences by virtue of the fact that they are social rather than natural, deal with aggregates of units and collective or composite dynamic tendencies or forces. They deal with mass effects,—with classes rather than with units or individuals, and every statement regarding a collective aggregate assumes compiled data.

Statistics presents compiled data relating to the production, distribution, exchange, and accumulation of wealth; it relates wealth accumulation to population increase, wealth production to rates of wages and other incomes, volume of credit to price fluctuations. It determines rates of criminality, insanity, and defectiveness for different classes, and thus measures the vital powers of resistance to degeneration and disintegration,—resistance, that is to say, of the individual, regarded as a unit in a collective aggregate, or of the institution of the family, or of some other social institution, in the selective struggle for survival. It measures the breeding power of the race, or stock, or class, against the mortality rate in such detail as may be significant, developing accurate and concise statements of tendencies, out of comparisons of present with past conditions. It measures accurately, and determines the direction of those obscure, insidious, hidden, and involved social tendencies which in the mass determine social evolution or devolution. With these data in hand the economist or the sociologist has a sure foundation of ascertained and demonstrated fact upon which to establish his speculative philosophy.

The statistician cannot perform a similar service for the natural or physical sciences, because these sciences do not deal with collective aggregates except incidentally. In chemistry or physics, and in fact throughout the range of the natural sciences, a single demonstration is frequently sufficient and final. Social laws and tendencies do not present to the scientific investigator that immutability, simplicity, persistence, and finality, which characterizes natural and biological laws. In the field of social phenomena demonstrations must be continuous or periodical. They can never be regarded as final, and all the terms of the social sciences are collective, that is to say statistical aggregates.

In dealing with social phenomena and conditions the statistician must be a free agent. In dealing, for example, with economic phenomena he is not working as an economist, utilizing the statistical method to develop economic science. He is regarding economic phenomena in all their complexity as presenting a field for independent statistical research. In this field he finds a fund of compiled statistical data relating to past conditions and tendencies, and each year new data are compiled and related to the data brought forward from past periods. The precise measurement of economic tendencies is thus extended, and every calculation is reworked to comprehend a new period.

Similarly throughout the field of social phenomena, the statistician works independently, and unbiassed by any speculative philosophy. Any given statistical induction may be of interest in one of its aspects to the economist, but it may at the same time in other of its aspects be of interest also to others—to the sociologist, the politician, the statesman, the lawyer, the doctor, the merchant, the philanthropist, to organizations of labor or of employers, and to various advocates of social reform and amelioration.

Wherever quantitative valuation is of significance in dealing with social aggregates, the statistician finds his proper employment. Statistics comprehends in all of its varied aspects the precise quantitative measurement, valuation and analysis of social life, and the accumulated results of such measurement, valuation, and analysis continuously carried on from day to day, from year to year, from decade to decade, and from century to century. Every new valuation acquires significance only in proportion as it is related to every similar valuation in the past, and in general with every other quantitative valuation of the past or present with which it may fairly be correlated. Statistics deals with absolute numbers primarily, but always with the end in view of determining tendencies and relativities.

In all of this work the prime characteristic of the statistician is that he has no hypothesis to prove nor any speculative philosophy to develop or validate. He is professionally indifferent to every sort of social propaganda, creed, doctrine, policy, theory, or opinion, and devoted singly to the development of statistical laws expressed as rates, incidences, distributions, averages, frequencies, and correlations, as determined by scientific compilation, refinement, and interpretation of data. By this process the statistician is enabled to forecast the future as regards social trends.

Properly and in character the statistician undertakes the interpretation of his data,—not a partial, but a complete interpretation. He may not be estopped from making an induction by the fact that the induction may have economic or sociological or political significance. All interpretations, even the most elementary, are bound to have some such significance, and certainly some interpretation of his data must be conceded to the statistician. That an induction happens to be significant is in fact a most excellent reason for making it. The statistician cannot fairly be restricted to the insignificant, simple, and obvious first differences,—to the barren, unrelated first results of his additions and subtractions.

Complete statistical interpretation of data does not, however, comprehend any speculative, ethical, or philosophical elements, since statistical data are in themselves purely quantitative statements, and do not carry any philosophical or ethical or speculative content. There is no "ought" or personality to statistical induction or analysis. The statistician does not pretend to incorporate within his science philosophies not inherent in it but imposed upon it, but he may fairly insist that statistical inductions themselves to their uttermost completeness, extending into every field of social research, are the natural organic developments of statistical science. Statistics does not embrace socialism, because the socialist happens to use some statistics as a basis for developing his peculiar philosophy, nor on the other hand are the statistical inductions which happen to be of interest to the socialist any the less purely statistical on that account. While statistical inductions are philosophically neutral, being in themselves neither conservative nor radical, neither individualistic nor socialistic, they must be nevertheless precisely and completely determined, and made available as the data of all real social science and of all social philosophy.

Purely hypothetical systems of reasoning may very well serve a real scientific end in a primitive stage of scientific development. Such systems have undoubtedly, for example, facilitated the primitive development of economics, but in proportion as data become available the economist is bound to undertake something more than the development of flawless trains of reasoning, originating in purely hypothetical assumptions and terminating therefore in conclusions of doubtful real significance. He is bound rather to undertake to explain economic phenomena in all their baffling complexity, to develop every conclusion from data, and to eliminate everything in the nature of a hypothesis.

So of other social sciences, it is true that they must all gradually abandon primitive speculations in the process of substituting data for hypotheses. It is admittedly much more difficult to develop a living science than it is to perfect a dead system of logic, but inevitably a social science which remains hypothetical, however flawless and perfect it may be, tends to become an inert, closed, rigid, uninspired system.

In the broad field of social research, it may be noted the vital problems have generally been precisely those implied in the traditional "ifs," which have been passed on from generation to generation,—such for example as the very large "if" implied in Malthusianism. Statistics would substitute data for these "ifs," not data in the raw, but data compiled, analyzed, interpreted. For every "if" it would substitute the final and ultimate statistical induction—not any philosophy, or doctrine, or ethics, or speculation imposed upon the data, but the very quintessence of the data, the pure, statistical, socially significant distillation of the data.

Every science has undergone or is undergoing this sort of sea-change from something strange into something real. The age of astrology and alchemy passes for all sciences, although no science easily frees itself entirely from its halo of hypotheses and mysticism. Psychology has developed out of painstaking and persistent experimentation, observation, and self-analysis, but it is still more or less involved in mystical speculations regarding the super-ego, the power of telepathy, our astral bodies, spiritism, levitations, and other strange phenomena which the science cannot comprehend or even concede to be real. So in other lines of scientific research, even today as has been true in the past, at a given point speculation supersedes science. In the social sciences, as in other sciences, speculation tends to supersede science at some point, and it must be added that at this point dissention and contention begin, because there is beyond the confines of science no sure foundation for reasoning or philosophy or ethics.

It is perhaps worth noting that stupendous errors have been committed in the development of social policies, philosophies, and speculations by the disassociation of scientific conclusions from the data upon which those conclusions have been based, by the specious substitution of social for natural or particular terms, or by the assumption that conclusions hypothetically or historically true are true absolutely for all time. War, for example, is proposed as a selective struggle and militarism thus becomes a natural political order. Again, because some forms of government are or have been evil, and the exercise of some powers by any form of government is or may be oppressive, the doctrine of *laissez faire* is developed, and government itself is declared to be essentially evil. Or again, poverty is declared to be a natural phenomenon because "if" population tends to increase faster than the food supply poverty is clearly inevitable. From period to period one or another falsely grounded or superannuated social philosophy has exerted its hypnotic spell over whole communities, seeming to tolerate, turn and turn about, now this and now that sort of social evil, and even to impose as a social duty the commission of certain outrages which a later age frankly condemns. In the field of social phenomena the hypnotic spell of false generalizations developed into social philosophies, policies, and ethics, has on occasion even tended to paralyze and render impotent organized agencies of social betterment.

Science itself does not commit blunders of this sort, but they are committed in the name of science, and particularly of primitive social science.

For these hypotheses and speculations especially, which have been or may be the occasion of blundering and misleading and contention in the field of social phenomena and conduct, statistics would substitute statistical inductions. It is the statistician's function to measure social tendencies precisely, not to reason or philosophize about hypothetical tendencies. It is his function to determine precisely rates and frequencies and correlations and probabilities in so far as these can be uncovered in collective social aggregates. This mass of living data which comprehends the future with the present and the past, this quantitative summing-up and statement of social phenomena and of social values constitutes the science of statistics. Skill and technique are means to an end in statistical work as in every branch of science and art. They are not in themselves ends, and will not serve to guide the statistician in electing the right course. He must bring to his work all the resources and guidance of a rounded-out science, which sums up past achievements, prescribes its peculiar technique, and gives direction to present endeavor.

THE ANALYSIS OF A CENSUS

By G. H. Knibbs, *Federal Statistician of Australia*

1. *General.*—At the present time the results of a census are usually published in the form of a series of tables, with some measure of analysis and interpretation in the form of comment. To a limited extent also, derivative results such as life-tables are sometimes given. But every competent statistician realizes that this is very far from furnishing any adequate idea of the real significance of the data, so labouriously acquired, and necessarily at considerable public expense. Hence the question naturally arises: "What ought to be the form of presentation of the results of future censuses?" This is the question I now propose to discuss.

Precedents already exist for doing much more than what is above suggested. The five professional papers published, for example, in connection with the United States Coast and Geodetic Survey are instances of the kind of thing which might well be done in connection with a census. The work itself in this survey consists of the measurement of base-lines, and of the angles of a network of triangles covering the whole area surveyed, together with the associated astronomical, chronometric and metrological work. This involves researches into the geometry of the earth's figure, into physics and geophysics, into practical astronomy, into the reduction of observations, into optical questions, into the measurement of the force of gravity, and so on. Indeed, one might quite properly say that the mathematical and physical sciences are all called into requisition for the purpose of the survey, and the researches cover a correspondingly wide range.

These researches are published (as already said) in professional papers, constituting not merely the appendix to the formal report, but often its most valuable element. Anyone acquainted with them realizes their value and the wisdom and public utility of the practice.

One might well say that a survey of the human beings occupying any territory is of at least as high on order of importance as the survey of the area which they occupy. Indeed the necessity of such a survey will emerge as soon as anyone attends to the facts; for indeed it must be self-evident that anything short of such a survey will not meet the inherent needs of the case. "The proper study of mankind is Man"; not merely in himself and in relation to his fellows, but also in relation to facts relevant to his well-being on the earth.

In this connection moreover it may be said that our ordinary statistical conceptions are not adequate. We think readily of "averages" but not of "distributions" about average values. The Belgian Astronomer-Mathematician Quetelet laid a foundation,—now quite a considerable number of years ago. But his conceptions, valuable as they were, are only a beginning. The notion of an average has to be supplemented by that of the characteristic of a distribution about the average or mean. And this desideratum has given birth to a new science, viz., the general theory of statistics and statistical results. This theory involves questions of probability, of the mode in which group-numbers arise, of the way in which individually observed facts are grouped (or dispersed) about their mean value, the dispersion or "scatter" itself often being a matter of high importance.

This is not the only element which needs development. We may have adequate grounds for believing that two series of facts are mutually related, and we may require a numerical expression for the degree of relation (correlation). By means of an appropriate analysis this can be obtained: thus we have a theory of correlation, which has wide applications in the Mendelian theory of inheritance.

Or yet again we may have data which, properly examined, enable us to see the law running through a series of phenomena, for example, the frequency of marriage or birth in the case of persons of different pairs of ages, and so on. When we can subsume the whole of the phenomena in question under some definite conception, expressible either by means of an algebraic equation, or by means of a graph, we powerfully advance our knowledge.

2. *Analysis and What It Involves.*—What has been said sufficiently indicates the general point of view. Extensive researches have already been made in various fields. The well-known "Biometrika" contains numerous instances both of methodological technique and of analysis. Various papers by Bachelier, Borthkiewicz, Charlier, Davenport, Edgeworth, Lexis, Livi, Pearson, Tschuprow, Yule, Westergaard, Wicksell, and many others, have laid the foundations of a method of great analytical power and importance. And though a comprehensive work on the whole range of statistical methodology is still a desideratum, it would be possible now to construct it. Its creation, however, involves both mathematical knowledge and practical experience in the statistical field, and unfortunately there are but few men who possess both the experience and the necessary leisure. Is not this a work for governments, or worthy of a private benefaction?

The Report on the Australian Census of 1911 contained, in Vol. I, an Appendix entitled "The Mathematical Theory of Population, of its

Character and Fluctuations, and of the Factors which Influence Them." This work (by the author of the present paper)—appreciatively referred to, among others, by American authorities—aimed on the one hand at supplying some necessary elements of mathematical technique, for analyzing various aspects of vital phenomena, and on the other at interpreting material made available by the first Australian Census which had been carried out on uniform lines and by a central authority. It embraced two elements, one technical or methodological, the other interpretative. An examination of it will reveal how current statistical data, supplemented by data rendered available by means of a census, can be made to furnish answers to important questions concerning the increase and character of a population.

It is easy to see that the questionnaire of a census, and the statistical material collected during intercensal periods, must be properly correlated in order to obtain the maximum advantage therefrom. Thus a satisfactory analysis may be said to involve three elements, viz.:

(i) Mathematical technique and methodology generally;
(ii) Appropriate correlations of data; and
(iii) Insight as to the significance of results obtained or obtainable.

The last is the only one to which we need now refer, and it will suffice, for the purpose of illustration, to mention but few elements.

The most fundamental thing about population is its rate of increase. But this depends largely, not merely upon its constitution with respect to sex and age, but upon its food-supply, its economic condition generally, and its standard of living. The last is a powerful factor in altering the rate of possible increase.

We are concerned, however, not only with mere numerical or quantitative results, but also with qualitative; and thus anthropometric measurements which can throw light upon the physique or upon the intellectual ability of a people are of high value. And they are very far-reaching in their consequence. The expansion of races, the difficulties of sufficiently increasing food-supply, the qualitative changes accompanying increasing density of population, the desirability or otherwise of miscegenation; these are subjects in regard to which inquiries are of momentous importance.

On the side of social-economics also, the issues are of no less significance. How national or private wealth is best measured, what are the characteristics of its distribution, how far, if at all, it is desirable that its accumulation should be restricted, how far national services should be nationally controlled or provided for by private effort, how far the levelling up as between nation and nation should be promoted,—these are questions calling for the highest order of statistical analysis, and are questions which may not be postponed without danger.

3. *Mathematics and Its Relation to Practical Results.*—There is a vulgar impression that a statistician is a mere tabulator of data, and that, when tabulations have been effected, the work of the statistician is at an end. As a matter of fact, however, his real work only then commences. And moreover even the tabulation of group-results needs to be directed by one who fully understands the significance of grouping, and what is essential to furnish accurate results in the case of critical facts, such, for example, as the age which corresponds to the highest frequency of marriage, birth, etc., the age of lowest mortality, and so on. But ignoring the last mentioned fact, we may note that crude statistical results are attained with considerable error, and one of the most important functions of the statistician is to eliminate this error as far as it is possible to do so. Thus, an acquaintance with the mathematical theory of error is an essential part of his professional equipment. This in its turn involves a knowledge of the characteristics of chance distributions, for these in many cases furnish a guide for the proper reduction of crude observations so as to furnish the best result obtainable from the imperfect data which come to hand. Again, to obtain the best results one may have to decide whether the crude data should be regarded as a chance-distribution at all, or whether the appropriate conception is that they are functionally related to the values of the variable age, say, in some other way. And this is by no means a simple question, it is one often involving a nice discrimination between points of view.

Again, we may have to ask ourselves exactly what it is that we are seeking to obtain? Is it—for example—that limit which would be attained with an infinitely large population (a sort of ideal result); or is it that which most simply represents a very limited one? And behind these questions lies the whole theory of the empirical representation of numerical facts. We substitute for the irregular results obtained regular ones which conform—if possible—to some readily expressible law. This subsumption of statistical facts under clear-cut conceptions is in conformity with the general method of science, and involves an appropriate command of mathematical theory.

We may take an illustration to make clear what is meant. Let us suppose that the age of most frequent nuptial child-birth is to be ascertained. In a small population the result may be prejudiced by irregularities in the data. Hence we first "smooth" them, getting rid of any zig-zag appearance of the results. Then, only, emerges the ideal curve to which the facts *tend to conform.* This is the essence of the matter. But to "smooth" results we must know the significance of first, second, and higher differences, or in other words the essential character of the curve which we regard as appropriately representing in their generality the facts examined. We are then, and only then, in a position to indicate with any exactitude the age in question.

It is obvious that life or mortality tables must conform to the requirements indicated in respect of smoothness, and so on. It is, moreover, easy to see that any general scheme of insurance must be based on appropriately *adjusted* data, and results derived therefrom. We need not further labour the point, viz., that mathematical science renders eminently practical service; it is really an essential in the proper analysis, representation, and indeed interpretation also, of statistical results.

4. *Indications of the Range of Statistical Analysis.*—In the first number of "Metron," published at Rome, will be found an article on the "Theory of Large Population Aggregates"* showing the significance of the mere theory of increase of population, and that the increase ultimately becomes zero, viz., when, for any given condition of things, the limiting density of population has been reached. At the rate of population-increase which characterized the last century this would arrive at no very remote date, and in any case the world's future food-supply will soon become a question of the first order of importance. This fact alone will suffice to emphasize the need for the analysis of statistics, and the necessity for entrusting it to experts of appropriate training and powers.

An indication of statistical analyses already carried out may reveal more clearly the real range and importance of the subject.† Starting with sex-ratio, we need to know what is the norm or average at each age for the whole western world, the ratio at birth and generally, for still and live births both nuptial and ex-nuptial, for the first-born, and so on. These facts are of sociologic importance and have a bearing upon national eugenics. Next the birth-rate itself and its relation to the marriage rate require to be ascertained, and where a mixture of races exists, and unrestricted miscegenation is opposed to popular feeling, the relative birth-rate of races within the population becomes itself a matter of far-reaching significance. From the standpoint of national development and from that of national eugenics, the effective birth-rate, after the infantile period—with its special dangers—has passed, is essential. The children saved from infantile disaster are what make up the effective population; in other words, mere birth-rate is itself of but little moment: it is the residual or effective birth-rate with which we are concerned. Thus, Australia and New Zealand, though they have not large birth-rates, are good examples because their residual rates are high: in short, as nations they do not bring children recklessly into existence, but when children do come into being there is an endeavour to save them.

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* By the author of this paper.

† In the Australian Census of 1911, by the author of this paper.

The drift of conjugal frequency and its distribution according to age, as affecting the birth-rate, as well as the stability of society, the inimical effects, and frequency of divorce, constitute a branch of social statistics which will not be neglected by students of sociology, or governments interested in national well-being.

The relative (or absolute) numbers of husbands of a given age, marrying or living with wives of a given age, may be defined by what the writer has called a protogamic or a gamic surface. The contours of this surface disclose the full conjugal particulars according to pairs of ages at a glance.

For calculating the number of marriages likely to take place, we need a theory of what may be called the *conjugal potential* of a community, and of its variation with changes in their economic condition. The change of probability with differences in the numbers living at each age needs therefore to be considered. Despite the fact that world statistics at present do not afford sufficient data to determine very exactly the form of the function by means of which the influence of variations in the numbers of unmarried persons can be eliminated, a function of high probability has been developed and tabulated, so that the elimination can be effected and the number ascertained.*

In order to represent the birth-rates of two populations in such a way as to eliminate differences in their age-constitution, we must have recourse to *natality indexes*, constituted similarly to mortality indexes.

To ascertain the age representing the beginning and end of fertility we need very extended observations. For Australia it appears to be about as follows:

PROBABILITY OF NUPTIAL MATERNITY

Age........	11	12	13	14	15	16	...	49	50
	0	0	.5?	.2?	.22	.41	...	.0088	.0033
Age.................		51	52	53	54	55	56	57	58
		.0012	.0006	.0005	.0004	.0025	.0015	.0005	.00000

Obviously, however, these numbers are not those of the ideal curve representing the fact as it would be were it not influenced in some way by limitations of the available data, by social tradition, etc.

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* By the writer of this paper: see Appendix I, pp. 214–223.

To express the relative frequency of first births after different durations of marriage and for different ages of women we need also a surface, so that the coördinates are: x = ages of the women; y = the duration of marriage; and z = the frequency. This surface may be called the *nuptial protogenesic surface*, or the *surface of nuptial primiparity*. In the graph of this, the contour for zero is the *agenesic boundary*, and the region outside of this is the *agenesic region, i. e.* it represents the series of ages and durations of marriage which are characterized by sterility. The average interval between marriage and birth for women of a given age may be called the *protogenesic index* for the age in question, and for women of all ages, the *general protogenesic index*.

The insight which this index gives in regard to the Malthusian modification of the physiological condition is of great and obvious sociological importance. It may be mentioned that for reasons which it is not proposed to detail here, it is necessary also to compute what has been called "*the protogenesic quadratic index*."* It may be mentioned that a correction to the calculated protogenesic index is necessary when the population is not constant.† Also the age of greatest fertility is not immediately given by the data, but requires correction for preceding cases of maternity. It is thus for Australia changed from: Age 18.8 and probability 0.483, to Age 19.0 and probability 0.517.

The preceding will afford some general idea of the nature of the analyses of some of the more simple elements which demand consideration. We shall now indicate some of the more complex cases.

5. *More Complex Elements Subject to Statistical Analysis.*—In dealing with statistics of fertility we are confronted with difficulties in regard to data. It has been shown elsewhere‡ that in statistics involving age and duration, where there are partially specified and wholly unspecified cases, these must be distributed according to the laws of probability, and that *unspecified cases follow a regular law*. When this has been done, then and only then can a satisfactory analysis be proceeded with. This being done for Australia it was found that the number of children at a confinement is a definite function of age, and that both for nuptial and ex-nuptial cases, the relative increase with age x up to about age thirty-six is sensibly given by the equation $B = 1 + 0.00065\ (x - 12)$ in which B represents the increase in the probability of a multiple birth; after that age the probability decreases again. Similarly the probability of triplets also increases with age, and is about 50 or 60 per cent greater in ex-nuptial than in nuptial

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* By the author of this paper; see Appendix referred to pp. 272–274.

† *Ibid.*, pp. 274–275.

‡ *Ibid.*, p. 302.

cases. The probability of twins occurring twice is nearly identical with the occurrence of triplets. The phenomena of ex-nuptial fertility are not very different from those of nuptial except that the maximum occurs about three years later, and tends to be *relatively* greater than the proportion indicated by the maximum from twenty-five years of age onwards.

When the duration of marriage and the age of the mother at the birth are both taken into account, say the ages being the abscissae (x) and the durations of marriage the ordinates (y), the relative frequency being then represented by verticals (z), the surface so defined may be called the *genesic distribution* at maternity. Or if the ages at marriage of the mothers be substituted for the ages at the birth, the distribution may be called the *gamogenesic distribution.* Thus we may adopt either or both for practical purposes, the gamogenesic tables denoting the proportion of wives who, having married at a given age (x), have during a duration of marriage of y years, borne k children.

In the preceding results the age of the husband, etc., is ignored: when taken into account the results become much more complex. The graph of birth-rates, based upon the ages of husbands as abscissae and of wives as ordinates, give a surface which I have called digenesic.* The contours defining equal birth-rates are appropriately called *diisogenic contours* and any series of ages giving a particular birth-rate may be called the diisogenic ages for that rate. Such surfaces reveal the rapidity with which the effective virility of the husband diminishes with age, and also the effective impairment of the wife, and reveal remarkable differences between different peoples.† Similarly we may construct surfaces for multiple diisogeny.

We shall consider but one other case of complex statistics, viz., that relating to mortality. It has been shown‡ that prediction tables for the frequency of death within a given duration of time, say one year, for persons of a given age are true only for a very limited time indeed. There has recently been a remarkable increase in the probable duration of life for nearly all ages, so great indeed that by the time a "life-table" has been constructed, it is already "out of date." The probable result for a given year can be obtained by extrapolating past results. The curves are sensibly exponential, concave upwards, the probability of mortality, as above said, decreasing with time. The general results show that the diminution in mortality is more marked in the young than in the old, and that it is not identical for males and females. The factors in operation are probably the following:

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* See Appendix referred to, p. 350.

† *Ibid.*, pp. 360–361.

‡ By the author of this paper, *Ibid.*, pp. 280–281.

(i) Evolution of the protective reaction between the organism and its environment.

(ii) Changes in the quantity, quality, and appropriateness of the food supply.

(iii) Changes due to the reaction of the organism to economic conditions in respect of its nutritional and neural apparatus.

(iv) Changes in personal and general hygiene, in therapeutics and surgery, in prevailing traditions which affect the vitality of an organism, etc.

I have shown that the facts of the variation of mortality with age suggest the following theory of its nature:

In virtue of its plasticity an organism is both vulnerable and recuperable. At birth the change of environment is inimical, the initial difficulty of adaption constituting the *natal "force of mortality."* This falls off very rapidly indeed, and constitutes what may be called the natal adaptative effort. The initial adaption being established in the course of the first few days, there follows what may be called the infantile adaptative effort covering, roughly, the first twelve months of life. The inimical forces are now greatly lessened, this period being characterised by the rapidly diminishing *infantile force of mortality.* The growing incapacity for adaptation gives rise to what may be called the *senile force of mortality,* which probably operates from the first. The pressure put upon the organism by social life, by the appearance of puberty, by the assertiveness of the reproductive forces, etc., constitute an inimical force, which vanishes with the termination of the reproductive period, and may be called the *genesic force of mortality.* The exhaustion and general dangers of reproduction also constitute for the female sex an inimical force which may be called the *gestate force of mortality.* There are also dangers of a casual nature, which may in their totality be called the *adventitious force of mortality.* General mortality is the sum of all these.

It is not proposed here to discuss the theory of an actuarial population, or the limitations of the Gompertz-Makeham-Laudi-and-Lazarus theory of mortality. It will suffice to observe that the whole position calls for revision by a competent mathematician.

Enough has been said to indicate that an ordinary population census can be made to tell a far more interesting, instructive, and valuable story than it does at present. It would be easy to multiply examples. To show for instance how the mortality-frequency according to age and sex for various diseases can be obtained, or, carrying the research into the fields of wealth and income, to show how a *plutoprosodic surface* can be made to exhibit the frequency with which particular incomes are associated with particular amounts of wealth, and so on.

6. *Special Reasons for Analysis at the Present Time.*—Apart from the general importance of statistical analysis in connection with a census, there are quite special reasons why this should be regarded as of more than ordinary moment at the present time. To these reasons we shall now refer.

The widespread movement towards democracy, the assertion of the claims of labour, the challenge of the rights of merely inherited wealth, the financial consequences of the great war, the question of the issues between production for use and production for profit, the anonymity and personal irresponsibility of capital and its reactions on nationalism, the social obligations of all members of any community to the community itself, the rate at which Nature's accumulated resources are being exploited, the possibilities of development of the world's food supply, the general raising of the standards of living, the international advance in eugenics, and similar questions, all indicate the urgency of the task before all great nations. None can afford to neglect to take stock of its affairs, to study its social and economic drift, to forecast its rate of exploitation of its recognised or available resources, to consider how it is to meet the various contingencies of national life, etc. Attention to these matters is indeed a national stock-taking.

Collisions between nations may perhaps be inevitable, but if they can in any measure be avoided, the dictates of reason indicate that this avoidance must be founded upon an intelligent appreciation of the whole of the circumstances of the case, including its relations with other nations. If the economic folly of collision and consequent destruction in war is to be replaced by intelligent and amicable readjustments of national interests, the way lies in a better knowledge of the comparative positions of the affairs of each nation. That is the only "way out."

We are denizens of a world of limitations. Collision of interests may perhaps be ultimately unavoidable, and is certainly inevitable so long as egoism is universal. War and death-struggle may perhaps be involved by the very "nature of things." Or it may not. Be that as it may, one cannot resist the conviction that if one hundredth part of what is spent in war were applied to a study of the problem of solving the difficulties between nation and nation, we should avoid a vast amount of trouble, and approach a partial, if not a complete, solution of international and internecine difficulties.

The proper analysis of a census is a first step towards a really systematic and incisive study of national and world affairs. Without such an analysis, conjecture, rather than knowledge, governs our thought and our action, and may lead us far astray. The powers at our disposal are becoming continually more terrible, and the "way of force" increasingly ruthless. One can assign no limit to the consequences of appeal thereto, and it may be taken for granted that the next struggle will be of a far more deadly character than that just ended. This surely must give us pause, and should lead all nations to appraise the real state of society, the meaning of individual, of communal and of national life.

There is, awakening in all thoughtful men, a feeling that we shall do well to ask ourselves the great question—"quo vadis". Whither is our civilization trending? What is to be expected if the universal appeal is to the power of inflicting injury?

One may well ask: "Are we in the throes of birth of a new era, and if so what will it witness?" Will it see the world marshalled in dread array in a ghastly appeal to the shrieking Bellona to call forth again the dogs of war, or will it witness a great endeavour to recognize that in that way lies irretrievable disaster and perhaps complete ruin. For be it remembered that we can command, as never before, the vast resources of our common mother Nature? It is not impossible that we may achieve even untold success in new instruments of destruction.

To these questions we may perhaps answer: "Destiny lies on the knees of the gods." Be it so, but we can survey its sway, perhaps can take an intelligent interest, not merely as fatalistic onlookers, but as intelligent coöperators. May it not be our privilege, as statisticians, to point the way in which the maximum safety lies over the uncharted seas of the future? Or if that be the function of the statesman, may we not furnish such a conspectus of international affairs, that the trend of Destiny shall be obvious, and the chart of the World Experience such that we can discern something of the Unknown into which we are continually passing?

I cannot believe that the leaders of intelligent nations will, in future, neglect to make available to all thoughtful men and women therein that survey of affairs which alone can guide our way. That way will either be appallingly stern, or will be gladdened by good fortune, according as the spirit of our decision sets right at defiance, or loyally recognizes it as the compass which must guide the barque of our world's life over the ocean of the future.

THE STATISTICAL METHOD IN PROBLEMS OF WATER SUPPLY QUALITY

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INTRODUCTORY

The concept of water supply quality has the simplicity of the unknown to the layman, but the complexity of the universe to the sanitarian. If one uses the mathematician's measure of the complexity of a function—the number of its attributes—the problem of water supply quality, a function dependent upon mutually active natural, physical, chemical and biological phenomena, offers an attractive field of study to the statistician. For the professional statistician has been concerned always with "quantitative data affected by a multiplicity of causes"[1] and with their elucidation. In considering the causes operating to produce relatively good or bad waters, such as rainfalls, pollution, purification, etc., and their interpretation upon the basis of laboratory findings and personal surveys it becomes manifest that problems of water supply quality fall well within the scope of statistical method. Just as in all statistical problems, so in that of water supply quality, the investigator is confronted with the two-fold task of determining the method of evaluating the units of interpretation and of defining the limiting values of such units. The method of approach to each problem involves a statistical viewpoint, as well as a quantitative methodology. The present paper has been prepared in order to illustrate, in as brief terms as possible, this statistical method of approach, by developing therein a few examples of its application to the question of water supply quality. The writer plans to trace the evolution of the concept of water supply quality in the sanitarian's mind and to point out in such a development the function which the statistical art has performed or may be expected to supply in the future. The discussion appears to be a necessary one since hitherto the water supply investigator has been accused of an aversion for the quantitative sciences, while, on the other hand, the professional statistician has shown a neglect of a field which perhaps did not appear to be worthy of his mettle. The present study may serve to remove this friendly distrust which retards in a degree progress in critical studies of water supply quality.

I. THE LABORATORY EXAMINATION OF WATER SUPPLIES

The sanitary quality of water supply must be predicated necessarily upon the demonstration of its relative inability to produce disease.

With the present germ theory of disease, such a demonstration resolves itself into the laboratory problem of enumerating the number and types of pathogenic organisms in stated quantities of water. It is apparent, therefore, that the technique in this instance is largely bacteriological, and the discussion, for purposes of simplicity, may be restricted to the problems of the evaluation of bacterial units, as illustrative of the statistical method.

It is manifestly impossible and impracticable to examine an unknown water in such manner as to determine its content of all kinds of bacteria or even of those relatively few classes of specific organisms which it is known are both disease-producing and capable of living in water. It is more desirable as well as convenient, therefore, to choose one family or group of micro-organisms whose natural habitat and life history are similar to the variety of pathogenic organisms and whose detection by laboratory methods is most simple and speedy. Bacteriologists have concluded that a particular class of bacteria serves as the most convenient index to water supply quality or contamination. They have chosen as this index class or type the so-called colon or bacillus coli group. The B. coli group has been so selected, because its origin is in general the colon or digestive tract of man and its presence is usually indicative of human sewage pollution (the possible and probable existence of colon types in other environments need not concern us at this point).

One of the primary objects of the bacteriologist, therefore, is to differentiate the bacterial species present in a water supply, so as to demonstrate the presence or absence of members of the B. coli group. In addition, it is necessary to obtain some idea of the relative frequency of such a group, since smaller numbers naturally connote a more remote pollution, due to the dying off of bacteria in the unfavorable environment of water, to the presence of antagonistic life, and to other natural and artificial barriers to its development. The problems arising in the laboratory differentiation of bacterial varieties offers, therefore, material for an initial example. Two general methods of distinguishing groups of bacteria are available. Both are based upon the method of differences. In the one case, morphological or structural characteristics, and in the other, metabolic distinctions control. Various classifications of the colon group, for instance, are based upon its ability to produce acid and gas from fermentable substances. Investigators have observed that certain types of B. coli ferment such complex organic compounds as sucrose, dulcitol and raffinose while others do not. Differences in the amount and character of gas formation from certain substances distinguish other types of bacteria.

In all classifications, however, it has been recognized that the same group may have a variety of reactions which overlap partially those of other groups. Two types of bacteria, for instance, may both ferment sucrose, but may differ in their effect upon a second or third compound. This gives rise naturally to a vast amount of possible combinations between characters and Levine[2] points out that "as the number of fermentable substances increases, the number of varieties increases geometrically approaching infinity. The number of 'varieties' is given by the formula 2^n where 'n' is the number of characters studied. Thus with 8 characters there are 256 possible combinations; this number rises to 1,024 with 10 characters and to 65,536 when 16 characters are observed. The absurdity of regarding each character as of similar and equal differential value is thus evident."

Levine, as well as other more recent investigators, has concluded that the principle of the correlation of characters should be emphasized in the attempt to distinguish bacterial species. He points out that certain properties have been universally accepted, after long checking, as reliable evidences of bacterial differences. Among such properties, he enumerates the selective dyeing of bacteria, their powers of spore formation, and their adaptation to aerobic or anaerobic development. The taxonomic value of the characters of motility, indol formation, and fermentation of certain compounds, on the other hand, he assumes to be still debatable. In order to avoid the adoption of a confusing classification of bacteria upon the basis of every character studied (of which we have indicated only a few) he has recourse to a basis of subdivision "on that character which gives the greatest amount of information as to the manner in which the resulting sub-groups react with respect to other characters."[2] By making use of the above principle Levine evolves a classification of coli-like bacteria which is based almost completely upon statistically evaluated correlated characters. For the purpose of this study, he recognizes two main strains of bacteria, the B. coli and the B. aerogenes-cloacae group, which earlier investigations have shown to be distinguishable most often by their reactions to methyl-red and to the Voges-Proskauer reagent. The first strain is usually methyl-red positive and Voges-Proskauer negative, while the second strain shows the reverse. The justification of this initial subdivision into two main groups consists in the fact that the strains thus subdivided show end products of carbohydrate fermentations of two entirely distinct kinds.

Levine's procedure consists in tabulating all of the reactions of the organisms studied in each of the above two groups in two different tables, from which are calculated the coefficients of correlation for each pair of characters. He selects, then, for subdivision that character which gives the highest coefficient of correlation with the greatest number of other characters. For these resulting sub-groups new correlation tables are prepared and further subdivision is made. These sub-groups are regarded as species and each is assigned its name.

In order to illustrate Levine's use of the coefficient of correlation for taxonomic purposes, let us follow his procedure in the subdivision of the B. coli, or methy-red positive and Voges-Proskauer negative, group of bacteria. For the 182 strains of this group that were studied by means of microscopic and metabolic methods, the coefficients of correlation shown in Table I were obtained.

TABLE I.

COEFFICIENTS OF CORRELATION OBTAINED FROM PAIRS OF CHARACTERS AMONG 182 STRAINS OF THE B. COLI GROUP

	Motility	*Indol*	*Sucrose*	*Raffinose*	*Dulcitol*	*Glycerol*	*Salicin*
Motility		−.39	+.53	+.43	+.53	+.18	+.40
Indol	−.39		+.08	+.00	+.02	−.28	+.76
Sucrose	+.53	+.08		+.99	+.58	−.38	+.20
Raffinose	+.43	+.00	+.99		+.58	−.29	+.27
Dulcitol	+.53	+.02	+.58	+.58		−.21	+.60
Glycerol	+.18	−.28	−.38	−.29	−.21		+.52
Salicin	+.40	+.76	+.20	+.27	+.60	+.52	

Since Levine's criterion for the choice of a character for subdivision is that that character should give the highest coefficient of correlation with most other characters, it is apparent, from an inspection of Table I, that sucrose, raffinose, dulcitol, and salicin meet this criterion more completely than do other properties. For special technical reasons, Levine chooses sucrose for primary division of the B. coli group and obtains by differentiation on sucrose ninety-three strains of the sucrose positive and eighty-nine strains of the sucrose negative groups. These two groups combined form, of course, the total of 182 strains initially chosen for study. Further study of the sucrose positive strains discloses a series of coefficients of correlation of characters as shown in Table II.

TABLE II.

COEFFICIENTS OF CORRELATION FOR PAIRS OF CHARACTERS AMONG 93 SUCROSE POSITIVE STRAINS OF THE B. COLI GROUP

	Motility	*Indol*	*Dulcitol*	*Glycerol*	*Salicin*
Motility		−.27	+.67	+.4[illegible]	+.54
Indol	−.27		+.05	−.42	+.28
Dulcitol	+.67	+.05		−.32	+.39
Glycerol	+.40	−.42	−.32		+.32
Salicin	+.54	+.28	+.39	+.32	

Table II indicates that motility is the best correlated character and this property provides, therefore, for two further sub-groups, a sucrose-positive motile sub-group and a sucrose-positive non-motile group. These sub-groups are treated in the manner already illustrated and the coefficient of correlation for different characters provide for further subdivision. With the aid of this statistical interpretation of his studies of 333 coli-like bacteria, isolated from various sources, Levine suggests a classification of bacterial varieties. The summary of this classification need not be repeated here, since the reader is interested more in his method of attack than in the resulting bacteriological findings.

Such classifications as Levine's supply the sanitarian with the qualitative information necessary for the interpretation of one phase of the water supply quality problem.* The analyst dealing with waters is concerned not only with the nature of the bacterial types present therein, but also in the magnitude of their content, since it is the latter which indicates the degree and the remoteness of pollution. In the search for a potable water, it is often useless to seek that water which has no possible source of contamination, but it is always necessary to determine the quantitative bacterial importance of the latter. The methods so far described answer only one question, that is, what types of bacteria are present in the water. In the solution of the second inquiry, regarding the number of a particular type in a stated quantity of water, statistical method has played recently an important part.

In the simpler tests for the B. coli group in waters, the so-called fermentation-tubes are used. These tubes contain the medium selected for most efficient differentiation of the B. coli group from other kinds of bacteria and are inoculated with specific quantities of the water to be tested. The production of gas in the tubes after stated periods of incubation indicates the presence of the B. coli group. Our knowledge that of five tubes, each inoculated with 0.1 c.c. of the water, four show the presence of the organism, is of value, but more important is the additional fact that such a series of findings indicates that the probable number of organisms in the sample tested is about 1,600 per 100 c.c. This conversion of qualitative fermentation-tube results into quantitative values is of special interest to the statistician.

In 1915, McCrady[3] showed that "the frequency of the appearance of the fermenting organism in the volume drawn from the sample for the test is an exponential function of the number of such organisms in the sample," and that "every fermentation-tube result, whether simple or compound, corresponds to one most probable number of organisms."

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*The subdivisions Levine develops have their importance to the investigator in the fact that species or varieties appear to be somewhat correlated with habitat or source of pollution.

By employing the theory of probabilities, he demonstrates that, given the result "$\frac{p}{p+q}$ in 1 volume," for instance, the corresponding most probable number is given by the solution for x of the equation

$$1-\left(\frac{V-1}{V}\right)^{x}=\frac{p}{p+q}.$$

Thus, for the result "five out of ten tubes positive in 1 c.c.," the most probable number is given by solution of the equation $1-.99^{x}=5/10$, since $V=100$ c.c., assumed as the original quantity of water sampled. The equation being solved, $x=69$ or the most probable number of B. coli in the sample, per 100 c.c.

For compound results, such as $\frac{p}{p+q}$ in 10 c.c., $\frac{r}{r+s}$ in 1 c.c., a more complicated formula is employed which is built up, as follows:[3]

For the result $\frac{p}{p+q}$ in 10 c.c. the equation becomes $(p+q)$ $(\log\ .9)$ $=\frac{p\ (\log\ .9)}{1-.9^{x}}$ which is obtained by differentiating for a maximum the equation given in the earlier paragraph for the probability of the results.

If the result is $\frac{p}{p+q}$ in 10 c.c., $\frac{r}{r+s}$ in 1 c.c., the equation stands

$$(p+q)\ (\log\ .9)+(r+s)(\log\ .99)=\frac{p\ (\log\ .99)}{1-.9^{x}}+\frac{r\ (\log\ .99)}{1-.99^{x}}$$

where $(p+q)=$ number of tubes inoculated with 10 c.c. of sample
$(r+s)=$ number of tubes inoculated with 1 c.c. of sample
$x=$ number of fermenting organisms in 100 c.c. of sample
p and $r=$ number of tubes giving positive results in 10 and 1 c.c. respectively.

If lower additional quantities of water are tested, extra similar terms are added to each side of the above equation. This equation has been modified by Wolman and Weaver[4] into

$$100\ (p+q)+10(r+s)=\frac{100p}{1-.9^{x}}+\frac{10r}{1-.99^{x}}$$

since, approximately, $\log\ .9=10\log\ .99=100\log\ .999$.

McCrady published later[5] a series of tables for the rapid interpretation of these results which makes the standardized use of the probable numbers of B. coli possible for the water supply investigator.*

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* The assumption of McCrady that the distribution of B. coli is similar to that in a mixture of a few red balls with many white balls is to be contrasted with the hypothesis of other workers that bacteria are uniformly distributed in water (G. C. Whipple[13]). More recent independent investigators, however, confirm McCrady's assumptions.

The work of McCrady was followed by other investigations dealing with the numerical interpretations of B. coli tests, of which the more important are Stein[6], [7], [8], Greenwood and Yule[9], and Wells[10], [11], [12]. The results of Stein and Greenwood and Yule, although differing in technique and in additional interesting viewpoints, are in substantial agreement with those obtained by McCrady. Stein[8] adds considerable interesting statistical material to the B. coli problem by introducing the so-called B. coli factor method, in which he considers the most probable number of B. coli per c.c. from the percentage of positive tests, the expected error of results, the study of the distribution of coli during a series of tests, and the "coli characteristic" which attempts to show by one figure, the average coli, the expected error and the variable distribution.

The discussion of the problem by Greenwood and Yule[9] has all the intricacy and mathematical complexity usually associated with Yule's contributions. Their findings, however, agree with those of McCrady and Stein. Greenwood and Yule, for instance, give as their formula for the number of B. coli per c.c., when using several tubes with 1 c.c. each

$$x = \text{B. coli per c.c.} = 2.3 \log \frac{p+q}{q}$$

whereas McCrady gives for the same condition (using an original size sample of 1,000 c.c.)

$$x = \frac{\log \dfrac{q}{p+q}}{1{,}000 \log .999} = \frac{\log \dfrac{q}{p+q}}{-1{,}000(.0004344)} = \frac{\log \dfrac{q}{p+q}}{-.4344} = -2.3 \log \frac{q}{p+q}$$

$$= 2.3 \log \frac{p+q}{q}$$

Perhaps the mathematician's interest may be aroused to the sanitarian's problems of water supply by the mere examination of Greenwood and Yule's discussions, while the bacteriologist may view with some alarm the same paper. It should be postulated in either case, however, that superficial considerations should not prevent the mutual aid which these two branches of science may extend to each other. While such complexity of treatment of the numerical interpretation of fermentation-tube tests as is indicated by the formula

$$P = \frac{\int_o^k \left[e^{-ha_1n_1}\left(1-e^{-ha_1}\right)^{m_1} \cdot e^{-ha_2n_2}\left(1-e^{-ha_2}\right)^{m_2} \cdot \cdot \cdot e^{-ha_nn_n}\left(1-e^{-ha_n}\right)^{m_n} \right] dh}{\int_o^w \left[e^{-ha_1n_1}\left(1-e^{-ha_1}\right)^{m_1} \cdot e^{-ha_2n_2}\left(1-e^{-ha_2}\right)^{m_2} \cdot \cdot \cdot e^{-ha_nn_n}\left(1-e^{-ha_n}\right)^{m_n} \right] dh}$$

may attract the statistician, it is hoped that it may not at the same time deter the laboratory technician from the adoption of devices which provide for more adequate solutions of his problems. Emphasis must be placed upon the fact that the mental attitude resulting from the adoption of statistical method has much promise in a field of endeavor where laboratory findings are too infrequently tested for accuracy of interpretation and rarely treated as examples of mass phenomena. The work of such men as Stein and McCrady has done much to introduce such methods by clarifying our concepts of fermentation tube results and their relative significance.

That the statistical method is an important asset in the exposition of laboratory findings is illustrated in another series of studies of various phases of water supply. Whipple[13], for instance, has demonstrated that "if, in a series of daily observations of the number of bacteria in a filter effluent extending over a year the deviation of any determination from the mean should be found to be more than five times as much as the probable error, to use a round number, this should be rejected from the series as being, for some reason or other, abnormal." He has made important contributions to the study of the frequency distributions of measures of various bacteriological, biological, and chemical characteristics of water, such as the preliminary finding that extended series of filter effluent results follow definite statistical laws in their distribution. His conclusion has been further substantiated by the more recent study of Wolman[14] of thousands of laboratory findings, in which it is indicated that the logarithms of bacterial counts, through long periods of time, have the characteristic normal probability distribution of more familiar biological statistical data.

It is of considerable interest to refer at this point to a form of graph presentation of data developed by a sanitary engineer which may be unfamiliar to most statisticians. Allen Hazen[15] in 1914 devised a form of chart ruled with a horizontal scale so divided that the curve of probability would plot thereon as a straight line. Any series of observations, therefore, which varied in accordance with the probability law would plot also as a straight line. Illustrations of the use of such paper in water supply problems may be found in the original paper of Hazen[15] and in subsequent discussions by Whipple[13] and Wolman[14].

Stein[16], in his study of the bacterial count in water and sewage, has added considerable material to our conceptions of the variability of laboratory findings and their importance in practical studies. He has concluded, after an interesting detailed analysis of the problem, that:

(a) For platings of a single sample of water, the mean error is equal to the square root of the number of colonies on a single plate, or the square root of the average number of colonies on several plates.

(b) The variations to be expected for careful and accurate work with bacterial counts are indicated by:

(1) Standard Deviation of ± 12%
(2) Deviation (1 in 10 times) of ± 25%

For ordinary routine work:

(1) Standard Deviation of ± 25%
(2) Deviation (1 in 10 times) of ± 50%

His comparison of the characteristics of bacteriological data with certain mathematical series should be of interest to the reader, since he shows, for example, that for daily tests of Lake Erie water for one month the Lexian Ratio is 29.00 and the Disturbancy Coefficient 124.00, while the corresponding values for a normal mathematical series (Bernouilli) are given as 1.00 and 0.00 respectively.

II. THE INTERPRETATION OF THE QUALITY OF WATER SUPPLIES

In preceding paragraphs the writer has indicated a few of the problems encountered in the laboratory technique of water supply examination, which lend themselves to statistical treatment. It has been impossible to include in the present brief paper any complete survey of such applications to other phases of laboratory procedure, but sufficient material has been presented, to demonstrate that the data in the field of laboratory technique have considerable to offer to the professional statistician as bases for the development of interpretative principles of quality.

The writer believes that some mention should be made briefly of certain interesting possibilities of development in the application of statistical method to general problems of laboratory procedure. The use of the coefficient of partial correlation, for instance, does not appear to have been introduced widely in the interpretation of laboratory findings, yet the necessity for its application is most apparent. Often investigative work in water supplies is carried out on a large or plant scale with the aid of analytical laboratory methods. In the study of the chlorination of a water supply, for example, a number of different variable quantities such as turbidity, color, organic content, and bacterial densities have their effect in modifying the efficiency of the disinfection process. In practically all conclusions from such studies no attempt is made to determine mathematically the effect of such variables, other than by mere inspection of tabulated data. There is little doubt that erroneous conclusions are often obtained through the failure to evaluate quantitatively the importance of fluctuations in the various characteristics of waters subject to chlorination. It is almost impossible to determine by qualitative inspection of a series of daily observations, over an entire year, of temperature, turbidity, color, organic content, and bacterial density in a water supply, whether the effect of a constant dosage of chlorine is influenced more greatly by any one of the above characteristics or by a combination of several or all of them.

The same problem arises, of course, in the study of any of the phenomena associated with the purification of water supplies. In the coagulation of suspended matter in water, for instance, all the variables such as time, agitation, temperature, hydrogen-ion concentration, nature of suspended matter, and character of coagulant play an interconnected part. The principle of partial correlation could be adapted with profit to these problems of associated phenomena.

The application of such a statistical principle as pointed out above is complicated, however, by the fact that the more simple statistical coefficients usually cannot be directly applied to the problems encountered, on account of the fact that such measures presuppose the use of data having a symmetrical or Gaussian distribution, while the phenomena with which the sanitarian has to deal often are characterized by asymmetrical distributions.[17], [18]

Michael[18] has discussed in this connection the determination of the most probable number of bacteria present in a sample and has demonstrated that it is not permissible to apply the probable error in the usual manner on account of the fact that the logarithms of the plate counts, and not the counts themselves, show a Gaussian frequency distribution[19]. McEwen and Michael[17] in another field of investigation have been confronted with the same problem of determining the "functional relation of one variable to each of a number of correlated variables" where such variables do not show the usual symmetrical frequency distribution. It is manifestly impossible to extend in this paper the elucidation of these applications of statistical method to problems of laboratory and plant, but the reader may find profitable data in the original papers already noted.

The opportunity for the application of statistical tests to problems of water supply quality is not restricted, however, to the materials of the analyst. The consideration of the potability of a supply involves always a series of mutually active attributes, each of which has its importance in determining the character of the water. The concept of quality connotes, therefore, a composite of properly weighted individual and fundamental units, in the evaluation of which statistics again comes to the fore.

It is unfortunate, however, that in the field of interpretation of quality statistical method has been even slower of application than in the corresponding study of laboratory data. The quantitative evaluation of sanitary data has always given way to the liberal exercise of expert personal judgment. Where a multiplicity of causes predetermines a phenomenon, such as quality, it was thought that a proper perspective was possible only through the development of a maturity of judgment in which the play of the manifold effects was qualitatively summarized rather than quantitatively analyzed. As the methods of diagnosis of quality developed, however, the opportunity for the fruitful application of the principles of mass phenomena gradually becomes apparent. With this development of a new viewpoint, good as well as evil sometimes resulted. A complete swinging of the pendulum to the quantitative side of interpretation was feared, where the attempt was made to substitute for individual experience and judgment pseudo-quantitative measures of doubtful significance. Some of these efforts, in which statistical laws frequently were ignored, will be discussed later in this paper. In general, however, a realization is gradually coming over the sanitarian that statistics as a means, rather than as an end, has much to offer in the clarification of his problems. If the succeeding pages seem somewhat bare, in their statistical implication, the professional statistician should remember that the concepts there discussed mark the advance of a new light in sanitary engineering, which, though feeble in its flicker, gives promise of a greater brilliance in the not distant future.

Attempts to formulate water supply standards of composite character represented one of the earliest applications of semi-statistical method. Most of these were based upon the erroneous conclusion that methods of evaluating units had been standardized throughout the country. Attention has been called to this fallacy of endeavoring to establish limiting values of units attained by varying methods by Hinman[20], Norton[21], and Morse and Wolman[22]. Fundamental training in statistical interpretation no doubt would prevent the adoption of water supply quality standards before the principles of unit evaluation have been rigidly enforced.

It is not amiss, perhaps, to call attention at this point to the close analogy between the so-called scoring of a water supply, or the quantitative allocation of the quality upon the scale of sanitary safety, and the statistician's concept of index numbers. Wolman[14] has shown recently that the operations involved in making a price index number are similar to those followed, to a greater or less extent, by investigators of water supply scores. In the case of price index numbers, the object of weighing is to give each commodity included in the index number an influence upon the results corresponding to its commercial importance. In water supply index numbers, the object of weighing likewise is to give each factor making up the score an influence upon the results corresponding to its sanitary importance. Although the problems in the two fields are the same, their solutions are necessarily different, since, in the case of water supply scores, the conversion to a common base of such units as bacterial results, sanitary surveys, operating efficiencies, etc., cannot be carried out because of the presence of varying personal opinion or judgment. It has been noted[14], however, that it still remains possible to make use nationally of simplified index numbers of water supply quality restricted in their range of significance and composed of similar units or, better still, of individual units, provided the method of evaluation of such units has been definitely and completely fixed.

Interpretations of the quality of a water include frequently more than a summary of the structural and environmental features of the supply. The possibilities of the intelligent and fruitful application of statistical devices, such as the coefficients of correlation and of variation, to other phases of water supply are mentioned only briefly here, since their complete discussion would involve a paper of a far too great length. Whipple* for instance, has suggested the use of the coefficient of correlation in analyzing the vital statistics of cities which have made changes from poor to good quality water supplies, in order to demonstrate quantitatively the existence of the Mills-Reincke phenomenon. Hazen[15] has made excellent use of statistical method in his analysis of the storage provided in an impounding reservoir on any stream and the quantity of water which can be supplied continuously by it. He introduces the coefficient of variation as a measure of the degree of variation in flows of different streams and by its further use has found it possible to get an approximate expression for the storage required to carry the surplus water of wet years over to dry years, which expression, in general terms, applied equally well to streams in different localities. In addition, he describes methods of estimating the probable errors in the results obtained and makes the important comment that "frank recognition of the large probable errors in many of the results cannot fail to be advantageous."[15]

The opportunities for further application of similar methods have appeared in the present writer's studies of the correlation of bacterial contents in water supplies with rainfalls upon stream watersheds and with hygienic resultants of inferior quality such as typhoid fever and diarrhoeal diseases. In these particular studies, the statistician could contribute excellent aid, since the writer is not aware of an effective method of comparing correlated phenomena in which one series of characteristics is continuous, while another is discontinuous. In addition, quantitative variations in magnitude of the values in both series are not of paramount importance, but the direction of such variations is the interesting event. The coefficient of concurrent deviations in this instance, does not appear to supply all the desiderata. An example may make our problem clearer. In the study of the daily tap water analyses of a city water supply, we find, by inspection, that the B. coli contents rise after rains on the watershed of the stream supplying the town. It is also found that such rises are masked, to varying degrees, by purification processes and by the efficiency of operation of such processes. If changes in method and efficiency of purification are brought about and the qualitative reflection of rainfalls in resultant B. coli density in tap waters is modified, how can we measure quantitatively the change in sensitiveness of tap water quality to rainfall from month to month? The data at hand for this purpose, reduced to simplest terms, are in each month B. coli values for each day (continuous series), which differ in density from day to day, and rainfall records (discontinuous series) which may give a zero value for all the days but three or four during the month. If, during the month of July, the B. coli per 100 c.c. rose from 2 to 2,000 from July 7 to July 8, following a rain of 0.8 inch on the stream on July 7, and during August the B. coli per 100 c.c. showed no jumps above 5 in spite of a number of days of rainfall of about 0.8 inch, what should be the statistical relation between the months of July and August for these particular considerations?

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* Personal communication.

This paper should not be concluded without some reference to the part that the study of purification processes has played in modifying and determining the quality of water supplies and the importance therein of the mathematician's tools. It is frequently the sanitarian's problem to include in his valuation of a water's safety some definite estimate, among other things, of the efficiency of operating features involved in the treatment of such a supply. This problem has given rise to various measures of treatment efficiencies, which only recently have been subjected to rigid statistical study. As an illustration of this type of measure the percentage removal of bacteria from untreated to treated waters has persisted. Statistical objections to this measure are well known to the reader and substitutes for this measure of performance, and indirectly of quality, have been much sought after. It was long recognized that the real measure of performance should include data regarding the distribution of the efficiencies over long periods and recommendations suggesting the classification of bacterial results according to frequency distributions have done much to clarify the interpretation of treatment figures.

Further development of the same problem of plant performance along statistical lines has been made by Wolman[23], in the study of the nature of bacterial removal in filtration plants. In this discussion, it was suggested that "the normal performance of a water filtration plant may be represented by a curve having the equation: $y=x^c$, where y and x are respectively the raw water and final effluents counts, and c is a constant for the particular plant under discussion." In other words, the tentative hypothesis was brought forth that the final effluent count, on the average, is an exponential function of the raw water count. The evaluation of "c" replaces also the unsatisfactory percentage efficiency as a more adequate measure, by using the ratio of the logarithms of the counts instead of the ratio of the actual bacterial values.

It is apparent that a measure of performance to be effective for adaptation to quality interpretation should include more than an array of its daily values, since it is the *consistency* of bacterial removal which predetermines the position of a form of treatment in the scale of the safety of a supply. Heretofore, no single unit of measure of this degree of consistency of removal has been available, although the fitting of normal performance data to the logarithmic curve of filtration supplied at least a graphic method of testing consistency.[23] If bacterial data are arranged and plotted on the probability paper already referred to in the discussion, it becomes extremely easy to obtain the values of the semi-interquartile ranges of the figures in successive steps of purification. The ratio of such values of the ranges for any two steps appears to the writer to present some promise of a real measure of the "levelling" effect of purification processes, since it measures the change produced in the frequency distribution of bacteria in passing through the treatment. The demonstration of its value may be more apparent to the reader by reference to material given elsewhere.[24]

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INCOMES OF BITUMINOUS COAL PRODUCERS

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An interesting table of the incomes earned by 1,551 coal producers in 1918 is included in the report of the Bituminous Coal Commission. The figures are based on returns made to the Bureau of Internal Revenue by producers of coal in connection with their declaration of income and excess profits. While there are perhaps 7,000 producers of coal, the Bureau of Internal Revenue was able to find complete returns for only those firms included in the tabulation. There was no conscious selection by the bureau, and the incompleteness of the list is due to the fact that among producers of coal are many companies engaged primarily in other business, and not, therefore, identifiable as coal companies. It is also true that in selecting the coal companies the clerks in the Internal Revenue Office, being unfamiliar with the industry, were likely to overlook companies that made no mention of coal in the company name. There were also several companies whose income tax returns were still under consideration and whose schedules were for that reason not in the statistical office at the time the tabulation was made.

The companies included in the table produce 30.7 per cent of the total coal output of the United States. A very careful analysis of the concerns included, convinced Mr. F. G. Tryon of the Geological Survey that if all of the companies had been included the results would not have been greatly different from those shown in the table. The companies are fairly well distributed as to size and geographical location, and, although the tabulation is incomplete, it may be considered as sufficiently representative to be significant. The table as printed in the report of the Commission is reproduced here without change.

An additional table showing certain items per ton and the average tonnage per company in each income group, is presented.

It will be noted that the classification of the companies is by percentage of net income on invested capital before deduction of tax. This classification is weak to the extent that invested capital is a bugaboo in accounting and in the work of the Bureau of Internal Revenue. It is, of course, much more significant than capitalization, which has no necessary relation to anything except the ownership of the equities in the concern. One criticism of invested capital is that it includes many large holdings of coal lands, which, though not at present being worked, are held for their future value. Coal mines thus unexploited

TABLE I.

TABLE PREPARED FROM 1,551 RETURNS OF NET INCOME FILED BY BITUMINOUS COAL-MINING CONCERNS FOR 1918, DISTRIBUTED ACCORDING TO THE RATIO OF NET INCOME OR NET LOSS TO INVESTED CAPITAL, SHOWING THE NUMBER OF RETURNS, THE AGGREGATE AMOUNT OF CAPITAL STOCK, INVESTED CAPITAL, NET INCOME, INCOME TAX, WAR PROFITS AND EXCESS PROFITS TAX, TOTAL TAX, AND THE NET INCOME AFTER DEDUCTING TAX; ALSO FOR THOSE RETURNS REPORTING LOSS, NET AGGREGATE LOSS. (ALSO TOTAL TONNAGE FOR 1918, SUPPLIED BY THE GEOLOGICAL SURVEY.)

	Number	Capital stock	Invested capital	Net income	Tax			Net income after deducting tax	Average per cent of net income to invested capital before deducting tax	Average per cent of net income to invested capital after deducting tax	Tonnage
					Income tax	War profits and excess profits tax	Total tax				
A. Returns reporting income:											
Ratio of net income to invested capital (per cent)—											
Less than 5	168	$28,582,464	$41,932,284	$897,407	$81,675	$1,492	$83,167	$814,240	2.14	1.94	9,452,285
5 to 9.99	159	51,082,688	73,668,946	5,819,355	641,328	70,249	711,577	5,107,778	7.90	6.93	18,292,627
10 to 14.99	158	61,005,338	94,881,665	10,798,316	1,150,697	1,084,054	2,234,751	8,563,565	11.38	9.03	26,433,974
15 to 19.99	134	39,062,476	76,089,233	12,925,742	1,037,659	3,661,204	4,898,863	8,026,879	16.99	10.55	26,750,835
20 to 24.99	103	16,742,404	47,264,900	10,886,366	806,626	3,796,539	4,603,165	6,283,201	23.03	13.29	15,443,012
25 to 29.99	66	11,085,063	22,841,827	6,184,866	377,269	2,839,684	3,216,953	2,967,913	27.08	12.99	9,965,090
30 to 39.99	125	17,955,923	34,512,152	12,232,299	662,260	6,400,444	7,062,704	5,169,595	35.44	14.98	20,837,882
40 to 49.99	74	14,150,490	26,238,024	11,336,439	557,200	6,471,382	7,028,582	4,307,857	43.20	16.42	15,693,759
50 to 74.99	97	6,266,100	15,216,439	8,930,410	430,340	5,146,941	5,577,281	3,353,129	58.69	22.04	11,806,639
75 to 99.99	65	2,598,851	6,667,509	5,735,847	247,899	3,514,584	3,762,483	1,973,364	86.03	29.60	7,987,053
100 to 149.99	39	2,077,885	3,588,619	4,296,253	178,907	2,778,866	2,957,773	1,338,480	119.72	37.30	4,373,005
150 to 199.99	12	249,572	424,511	756,770	33,080	456,420	489,500	267,270	178.26	62.96	910,734
200 to 299.99	8	115,700	137,597	351,451	13,205	224,930	238,135	113,316	255.42	82.35	498,365
300 to 399.99	2	4,300	11,772	39,366	2,532	14,265	16,797	22,569	334.40	191.72	144,656
400 to 499.99	2	18,000	33,244	138,072	5,102	91,546	96,648	41,424	415.33	124.61	166,181
500 and over	2	5,300	11,824	125,248	7,389	59,669	67,058	58,190	1,059.27	492.13	137,254
Total reporting net income	1,214	251,002,554	443,520,546	91,454,207	6,233,168	36,812,269	43,045,437	48,408,770	20.62	10.91	168,893,351
B. Returns reporting loss:											
Ratio of loss to invested capital (per cent)—											
Less than 5	106	9,593,808	14,468,873	340,894*	....	....	....	....	2.36*	....	3,901,970
5 to 9.99	58	3,935,362	5,129,012	359,162*	....	....	....	....	7.00*	....	1,991,389
10 to 14.99	32	3,146,905	3,034,632	390,149*	....	....	....	....	12.86*	....	1,488,947
15 to 19.99	29	1,471,750	1,602,321	278,449*	....	....	....	....	17.38*	....	1,001,002
20 to 24.99	20	1,105,860	1,267,789	287,823*	....	....	....	....	22.70*	....	606,234
25 and over	92	1,679,154	1,942,604	963,255*	....	....	....	....	49.59*	....	2,019,994
Total reporting loss	337	20,932,839	27,445,231	2,619,732*	....	....	....	2,619,732*	9.55*	....	11,009,536
Total A and B	1,551	271,935,393	470,965,777	88,834,475	6,233,168	36,812,269	43,045,437	45,789,038	18.86	9.72	179,902,887

* Loss.

TABLE II.

TABLE FROM 1,551 RETURNS OF NET INCOME FILED BY BITUMINOUS COAL MINING CONCERNS FOR 1918, DISTRIBUTED ACCORDING TO THE RATIO OF NET INCOME OR NET LOSS TO INVESTED CAPITAL, SHOWING THE TONNAGE PRODUCED PER COMPANY, THE INVESTED CAPITAL PER TON, THE NET INCOME PER TON, TAXES PER TON, AND THE NET INCOME PER TON AFTER DEDUCTING TAXES.

Income group	Per ton				Number of companies	Tonnage produced per company
	Invested capital	Net income	Taxes	Net income after deducting taxes		
Average for all companies:	$2.62	.49	.24	.25	1,551	115,992
Companies reporting net losses of:						
25% and over	.96	.48*			92	21,956
20–25%	2.09	.47*			20	30,312
15–20%	1.60	.29*			29	34,517
10–15%	2.04	.26*			32	46,516
5–10%	2.57	.18*			58	34,334
Less than 5%	3.71	.09*			106	36,811
Companies reporting net incomes of:						
Less than 5%	4.44	.09	.09	.09	168	56,264
5–10%	4.02	.32	.04	.28	159	115,048
10–15%	3.58	.41	.08	.32	158	167,304
15–20%	2.84	.48	.18	.30	134	199,633
20–25%	3.06	.70	.30	.41	103	149,932
25–30%	2.29	.62	.32	.30	66	150,986
30–40%	1.66	.59	.34	.25	125	166,703
40–50%	1.67	.72	.45	.27	74	212,078
50–75%	1.28	.76	.47	.28	97	121,718
75–100%	.83	.72	.47	.25	65	122,879
100–150%	.82	.98	.68	.31	39	112,128
150–200%	.47	.83	.54	.29	12	75,895
200–300%	.28	.71	.48	.23	8	62,296
300–400%	.08	.27	.12	.16	2	72,328
400–500%	.20	.83	.58	.25	2	83,091
500% and over	.09	.91	.48	.42	2	68,627

* Loss.

naturally tend to decrease the percentage of net income. There may, therefore, be some question as to whether this inclusion is fair or not. However, in view of the fact that a coal mine is depleted with comparative rapidity, the holding of unexploited mine lands, with the resulting interest charge, may be considered as a part of the business. As an offset may be mentioned the fact that many companies have leaseholds on coal lands for which they pay a contract price far below the present market price; this element would tend to increase the proportion of net income to invested capital. There is room for debate on the validity of the investment figures, but it may perhaps be said with fairness that, since the basis throughout the tabulation is uniform, the figures are significant as between group and group, even though they may not offer a sufficient basis for final judgment as to the amounts earned by the coal producers.

The Report of the Bituminous Coal Commission points out that of the 1,551 companies included, 337, or 22 per cent, reported net losses in 1918, and 168 companies, or 11 per cent reported net incomes of less than 5 per cent on invested capital. One-third of the companies involved, therefore, were not making what may be considered a fair return on their investment. The significant fact, however, is that these companies represent only about one-seventh of the total invested capital, and about one-ninth of the total tonnage. Since the capacity of our coal mines is approximately 700 million tons per year, and the national requirements are approximately only 500 million tons a year, it is clear that the nation's needs can be supplied even if these unprofitable companies are diverted into other lines of business. In fact, there is no hope for a thorough stabilization in the coal mining industry unless the high-cost mines are shut down, at least temporarily.

The coal mining business requires, in many cases, comparatively little capital, and even before the war many concerns were engaged in coal mining on a speculative basis; that is, small concerns acquired entries which they held against the day when a heavy seasonal demand would make it profitable to work the mines. Such producers might enter the field in the fall months, operate for a few weeks and realize enough during that period to pay for their comparatively small investment. In trade parlance, such producers are called "snow birds" because they ordinarily operate when there is snow on the ground and when the demand for coal is at its peak. Owing to the exceptional demand for coal, and because of the fact that the government fixed the price of coal on a basis sufficiently attractive to induce all companies to increase their output to meet the exceptional national requirements, the number of high-cost mines increased materially during the war and other mines were induced to expand their production beyond the limits which national economy in times of peace would justify. There is little question that those producers whose operations were profitable only because of exceptional demands caused by the war, will be forced out on the return of business to normal conditions. This is only fair as the nation cannot be expected to support uneconomic mines simply because they happen to be in the field. If, in individual instances, it could be demonstrated that the mines were operated on a purely patriotic basis in order to help the nation in its hour of need, the American people could much better afford to refund to such proprietors the whole of their investment rather than attempt to maintain a price that would make it possible for them to continue in business.

In view of the large number of companies involved and the keen competition which prevails in the industry there is little danger of price agreements that would enable the unprofitable mines to operate. It is to be expected that the nation's coal requirements will be supplied by companies having sufficient natural or geographic advantages to be able to produce coal at a figure representing a peace-time "bulk line." Only by establishing this basis of production, and coupling with it the plan of the Coal Commission to provide an even distribution of the demand throughout the year by inducing the large consumers to purchase their supplies in the summer months, can the industry be placed on a stable basis which will insure during twelve months of the year profitable employment for the capital and the labor involved. It is well known that at the present time only about two-thirds of the working days are days of operation in the coal mines. From the national point of view there is no justification for supporting what may be termed excess capital and labor in the industry. Moreover, the resulting intermittency of employment has been the main cause of labor unrest, on the one hand, and of the serious car shortage during the rush season, on the other.

The table shows further that about 36 per cent of the operators having about 62 per cent of the total invested capital and producing about 48 per cent of the total tonnage were earning between 5 and 25 per cent on their investment. This group may therefore be considered as carrying the bulk of the coal production. Other companies, still more fortunately situated, made much larger returns, and it is the returns of these companies that have given rise to a great deal of public discussion. It is significant that the companies making over 25 per cent return represent only about one-fourth of the total investment and two-fifths of the tonnage, while the companies making returns of over 100 per cent represent only about 4 millions of investment and about 6 millions of production. The companies reporting very high rates of return on their investment are small concerns with investments of only a few thousand dollars whose net income represents to a large extent the earnings of the owners for their own labor, management and risk. They are speculative investments and, although they may make 100 per cent on their money one year, market conditions may be such in subsequent years as to make it unprofitable for them to operate their mines at all. In fact, it is to be expected that under present conditions these small concerns will not be able to operate and that their short-lived war profits will represent perhaps all of the return on their investment.

The table of averages shows that the 1,551 companies included produced about 116 thousand tons per company and that the production of the companies reporting losses was, in the case of no group, greater than 47 thousand tons a year. The companies having net incomes of less than 5 per cent averaged only 56 thousand tons a year, while the companies in the other income groups had very much larger average productions. The companies earning between 15 and 20 per cent produced about 167 thousand tons per company and the 74 companies earning between 40 and 50 per cent produced an average of 212 thousand tons a year. It is of interest that the companies in the income groups above 200 per cent averaged less than 76 thousand tons a year.

For the companies earning net incomes, invested capital per ton decreases with almost unbroken regularity as the income earned by the group increases. In other words, the main reason for good profits in the industry is the possession of a mine which assures a large coal output per dollar invested. The companies earning less than 5 per cent have an average investment of $4.44 per ton, while those earning 500 per cent and over have an average investment of 9 cents per ton of output.

On the other hand, it is significant that net income per ton does not increase with any degree of regularity with the increase in the returns on investment. Although the companies earning less than 5 per cent earned only about 9 cents per ton, the companies earning between 20 and 25 per cent earned 70 cents per ton, as compared with 62 cents and 59 cents per ton respectively for the companies in the two succeeding income groups. The largest earnings per ton—98 cents—are shown for the companies with a return of between 100 and 150 per cent on their investment, while the companies earning between 300 and 400 per cent earned only 27 cents per ton. In other words, the determining factor is a large output per dollar invested rather than a large profit on each ton produced.

The average amount of capital invested per ton of product for all of the 1,551 companies included was only $2.62, which is perhaps the principal reason why expansion of the industry beyond the economic limit has prevailed. An investment of only $2.62 per ton of coal, which is considerably less than the selling price per ton, is indicative of an industry in which labor cost and risk are the fundamental elements determining cost in the long run. On the investment of $2.62 per ton the companies, including the losing concerns, earned on the average a net income of 49 cents per ton, of which the government took 24 cents in income and excess profits taxes, leaving 25 cents available for distribution among the proprietors. A net income, above taxes, of 25 cents per ton would seem to indicate that the industry on the whole was on a substantial basis of profit in 1918, which was a good year, although after the signing of the armistice production fell off materially.

The Bureau of Internal Revenue, which very properly guards with extreme care the private information of the taxpayers, seldom gives to the public a statement of facts sufficiently illuminating to furnish an insight into the financial conditions of an industry. There are those who maintain that income and excess profits tax returns should be a public record available for the inspection of any taxpayer. While such a degree of publicity is of questionable desirability, since it would be likely to operate against the accuracy and the truthfulness of the returns, it is certain that tabulations like those presented in the report of the Bituminous Coal Commission and reproduced here are of great public interest. It is equally certain that the economists and statisticians of this country would do well to encourage the Bureau of Internal Revenue to compile summarized statements of the earnings of companies in different industries. Such compilations reveal no individual's private business, and at the same time furnish a mine of valuable information regarding economic conditions in the different industries.

REVIEWS

Economic Phenomena Before and After the War; A Statistical Theory of Modern Wars, by Slavko Secerov. London, Geo. Routledge & Son, 1919. Pp. viii, 232.

This thesis, presented for the M.Sc. degree in Economics at the University of London, is an interesting but somewhat disappointing work. Although the theoretical reasoning is much better than the statistical support presented, yet some features of the theory do not seem cogent even on purely *a priori* grounds.

The main contention of the study is that war is a function of increasing disturbance of the economic equilibrium in advanced industrial communities. The state of economic equilibrium is a result of a balance between the factors of production and consumption. On the side of production chief importance attaches to the relative proportions of primary and secondary goods, when by primary goods is meant food and raw materials, and by secondary goods, manufactured articles. Primary goods are produced under the law of decreasing returns, secondary goods under that of increasing returns. The capitalistic community is under a constant propulsion to decrease its production of the former and increase the production of the latter, seeking, at the same time, to maintain a balance between the two by trade with less advanced communities, which are themselves being pushed toward industrialization by the accumulation of capital. On the side of consumption chief importance attaches to the growth of population and changes in the standard of living. In general, then, the thesis is that in advanced industrial communities there is a marked tendency for the production of primary goods to fall behind the growth of population and the rise in standards of consumption. This gradual disturbance of the economic equilibrium is corrected by war which checks the production of secondary goods, stimulates the production of primary goods, reduces population and depresses the standard of living.

Thus far the thesis is one that has in substance been expressed before (E. Van Dyke Robinson, *War and Economics in History and in Theory*, Pol. Sc. V. 15, pp. 581–622; W. S. Thompson, *Population, A Study in Malthusianism;* and E. Dana Durand, *Some Problems of Population Growth*, Quar. Pubs. A. S. A. V. 15, pp. 129–148) and even more effectively, for the style of this book is frequently marred by foreign accent. But the author further refines and elaborates his theory. In the first place the marriage rate, the death rate, and hence the rate of population increase are dependent on the ease of earning a wage sufficient to maintain the standard of living. This can be shown by a comparison of price index-numbers and percentages of increase in population. This has considerable validity in theory but the figures used (Table I, p. 50) indicate that the rate of population growth varied directly with the price level, especially if a lag of ten years be allowed. "As the increase rates fell from 18.1 per cent in 1811–21 to 11.9 in 1851–61, the average price index numbers fell from 156 to 89, etc." (p. 51). This means that a rise in prices stimulates population increase and vice versa, a conclusion contrary to his own theory and to common sense. Fortunately for the author's peace of mind this table is brought down to the close of the century only. Could he today contend that the rapid rise in prices in England and Wales since 1900 has been paralleled by growth of population? The fact is that for a generation the birth rates in Western Europe have been declining so that the secular changes of price levels and of birth rates were directly correlated for some years before 1896. But these secular movements of prices and birth rates have been inversely correlated since. Moreover the author does not either theoretically or inductively show that short-term fluctuations of price levels and population movements are related.

But there is an additional aspect to the theory of population movements, namely, that (1) a special pressure of population on living conditions is shown immediately before war, while (2) there is a release of reproductive forces immediately following war. This last proposition has long been accepted and explained as a consequence of the check which war inevitably gives to marriage and marital relations. The author however contends that this post-war "ascending phase" of population growth is due to (1) a lowered standard of living and (2) greater ease of getting a living, largely owing to the loss of life during war. This explanation is left in the realm of *a priori* reasoning. Moreover the assertion (p. 68) that in the post-war period "the winning party is progressive, the losing stationary or retrogressive" is not demonstrated; it is in fact directly contrary to all data presented (pp. 56–61).

As to "the pre-war declining phase" of population growth, the author nowhere makes a convincing case. His best case is that of Prussia and France and the War of 1870–71. Take France, for example. By taking the years 1867–69 as the pre-war period he shows (p. 57) a decline as follows: 1867, 3.7 per 1,000 population; 1868, 1.6; 1869, 2.2. But one could do equally well by selecting other dates. Thus: 1863, 4.4; 1864, 3.9; 1865, 2.2. Moreover by starting at the low point of 1865 one could almost show a pre-war *ascending* phase, the figure for 1866 being 3.2. The drop in 1868 and 1869 is not less striking than the fall from 3.2 in 1856 to 1.1 in 1859 or the rise again to 3.7 in 1861. In Prussia the presence of cholera during the pre-war years admittedly caused such violent fluctuations as to obscure the operation of economic factors.

The author's study of data preceding the Great War is even less convincing. There has been a general tendency toward a decrease in the growth of population in all western Europe. If one is to find in that an indication of approaching war he will see only what one can see even more plainly where population is increasing. Moreover the fluctuations from year to year cannot be made the basis for statistical proof unless they are separated from the general trend and shown to be of significant proportions. Thus a decline in the French rate of growth from 1.5 in 1912 to 1.3 in 1913 can hardly "be taken as significant for forces affecting equilibrium" (p. 64) in view of the statement on the same page to the effect that the rates varied as follows: 1908, 1.2; 1909, 0.4; 1910, 1.8; 1911, 1.1. The drop from 1908 to 1909, or 1910 to 1911, or the rise from 1909 to 1910 was in each case several times greater than the fall 1912–1913. This instance is typical of much of the author's work. There is an uncritical and not altogether candid use of statistics; there is also no device for testing whether a difference is significant or not.

But equally important with growth of population, in the opinion of the author, is growth of consumption. His theoretical discussion is interesting and illuminating. With a rise in the standard of living, consumption of both primary and secondary goods is extended. Thus industrial communities produce proportionately less primary goods while steadily demanding more; at the same time they advance rapidly their production of secondary goods. The increased pressure upon the supply of primary goods has the effect of checking population growth so that, "if there is a steady and continuous decline in the rate of the natural growth of population, and a steady rise of consumption war is probably approaching" ("General Summary," p. 188). This quotation embodies the most unique proposition in the study,—a proposition that is far from demonstrated. He can show an increased per capita consumption of various fundamental foods during the 19th century, but he cannot show convincingly either "a pre-war declining phase of the natural growth of population" or "a pre-war ascending period of consumption" (p. 105). His study of consumption is subject to criticisms similar to those already noted regarding his treatment of the subject of population. Take, for example, the Franco-Prussian War, pp. 110–117. In Table 22 he presents the annual per capita consumption of wheat and rye in Prussia. But before noting figures it should be mentioned that the author adds still another special quirk to this theory by contending that the imminent approach of war is indicated by a "special pressure area" of two or three years. In other words war is made probable by a persistent rise in the standard of consumption (plus lessened growth of population) and is virtually ushered in by a sudden decline of consumption. Data for Prussia are scarce and faulty "but the available statistics confirm the theory." Table 22 gives the per capita consumption of wheat and rye, during the years 1856–69, as follows: 1856–58, 173.2 kgs; 1859–61, 169.8; 1862, 161.1; 1863, 163.4; 1864, 166.9; 1865, 162.2; 1866, 162.2; 1867, 155.9; 1868, 149.8; 1869, 156.0. Presumably the years 1862–67 (or 1866) are the years of ascending consumption, and the years 1868 and 1869 those of "pressure on consumption." Several things may be said about these figures: (1) if one take the average for the eight years 1854–61 (figures for 1853–55 average 159.3) he gets 167.4, while the average for the eight pre-war years is only 159.7; thus the ascending phase becomes descending; (2) why do they not show the wars against Denmark and against Austria in 1864?; (3) elsewhere, when using agricultural data that do not fit, the author explains them away as due to the fluctuations of nature, as on the next page where he finds he cannot rely on wheat and potatoes for France for the figures are "irregular, probably due to bad harvests." There are four such excuses in eight pages (112–119). Hence for Prussia he uses wheat and rye because they fit; for France he cannot use wheat and potatoes and falls back on sugar and five drinkables, wine, spirits, beer, cocoa and tea. Apparently the French had little use for solid foods before the War of 1870; perhaps the true cause of the war was that excessive drinking on otherwise empty stomachs aroused an excess of martial spirit. The figures for Paris are no more convincing. Here data for meat consumption are given but they decline from 1864 to 1867 inclusive when they should rise, and then, during the "special pressure" period heralding the coming of war, they go up. What can a statistician do with such perverse figures, anyway, but to set them down and ignore them! His case is not strengthened, even by the further data giving the per capita consumption of *vanilla* and *pepper* for all France.

This sort of criticism could be extended indefinitely, especially if one were to take up the data given for years preceding 1914. There is reliance on chance variations, emphasis on insignificant differences, and crude handling of averages (pp. 144 and 145). Excuse is offered for data that do not fit but use is made of exactly similar data when they happen to fit the theory.

There is still a final proposition, namely, that war reëstablishes equilibrium by increasing the production of primary goods. Here again the author seems unable to make a clear case statistically. His theory that such production increases during war and that, following war, it continues to increase in the losing territory, seems sound enough; as does also the theory that such production will decrease in the winning territory because the object of war is to acquire control of supplementary areas which will provide foods and raw materials. But one cannot readily apply the same reasoning to Russia in the Russo-Japanese war and to England in the British-Boer war, owing to enormous differences in stages of economic development. Moreover the fluctuations in crop acreages from year to year are such that, in the absence of some method of showing general trend and the significance of variations therefrom, the statistical table becomes meaningless.

In spite of failure to establish clearly the special features of his theory, the author has given us another demonstration of the fact that the progressive industrialization of the Western World must encounter increasing difficulties as other communities move in the same direction. As supplementary areas grow small and gradually become barely self-sustaining, or even partially dependent as regards foods and raw materials, the capitalistic phase of world development must gradually give way to one in which standards of taste are less pecuniary and industrial organization less exploitative.

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The Italian Emigration of Our Times. Robert F. Foerster. (Harvard Economic Studies, Vol. XX.) Boston, Harvard University Press, 1919. Pp. xv, 556.

Dr. Foerster has produced a book for which all students of migrations will be grateful. It unmistakably shows a first-hand knowledge of the conditions of the Italian emigrant both at home and abroad, as well as a complete mastery of the literature. Moreover, unlike the work of most American scholars, it is written in a graceful style, rising at times to real beauty and distinction.

What distinguishes Dr. Foerster's work from that of most writers upon the subject is that, like Miss Balch, he rightly makes emigration from the homeland, rather than immigration into any one country, the center of the problem. As the result of an admirable statistical study, he shows that in the forty years preceding 1914, between sixteen and seventeen millions of emigrants left Italy. This figure, however, represents a certain amount of duplication since it includes the reëmigrants and the seasonal laborers who, before the war, went forth annually to work in the European countries and even as far away as Brazil, only to return in the winter. Dr. Foerster estimates that of the total emigration, approximately two-thirds was temporary and either had returned or would return to Italy. Something over four millions, however, had been finally lost to the country.

The early emigrants came chiefly from the northern provinces, but since 1900, the south has furnished the chief source. Four-fifths of them are males and the great majority unskilled laborers coming from the rural districts.

The forces causing this unparalleled migration are impelling rather than alluring. The emigrants are driven out by the economic pressure of an overcrowded population working upon infertile soil with the most primitive of tools and rudimentary of agricultural practices. Added to this is the system of large landed estates whereby high rents are exacted by absentee landlords and in the south the widespread prevalence of malaria. The inevitable result is a condition of misery which, in Sicily and the south especially, was scarcely equalled in any European country prior to the war.

Such, then, are the causes which have brought about this exodus of millions. Where have they gone? Everywhere that there has been economic opportunity. Both in the causes of emigration and in the direction which it has taken, economic factors, therefore, have almost completely predominated. Dr. Foerster describes, with a wealth of detail, the wide distribution of the emigrants. Large numbers have entered every European country, save Great Britain and Russia. Dr. Foerster points out the little known fact that of the transoceanic emigrants, the majority have gone to Argentina and Brazil. His chapters on the migrations to these countries are indeed a unique contribution. He computes that the native-born Italians form as much as one-seventh of the total population of Argentina while the Italian stock as a whole comprises approximately one-third. Most of the migrations to South America occurred prior to 1900, and consequently were largely composed of emigrants from the north. Since then, the main channel of emigration has of course been to the United States and has been composed chiefly of south Italians. Great as has been the Italian immigration into this country in the last twenty years, it has not as yet equalled the total number that have entered Argentina and Brazil.

The conditions of life of the Italians abroad are, with few exceptions, but slightly less severe than in Italy itself. They are almost uniformly unskilled laborers, whether they are at work in the mines of Germany and France, on the construction jobs or in the harvest fields of central Europe, the coffee plantations of Brazil, or in the mines, manufacturing industries and construction camps of the United States. Relatively few become skilled craftsmen, although many enter the small merchant class. In the Argentine the rigorous labors of the Italian immigrants have been largely absorbed by the native landed aristocracy in the form of enhanced land values and rentals while the Italians themselves have not prospered in proportion to their efforts.

Low as their wages have been, Italians abroad have sought desperately to save in order that they might return to Italy with "their pile." Their low wages, their desire to save, and their previous low standards all cause their mode of life in foreign lands to be unsanitary and unsuitable. Moreover, the same forces have led them in industry to overstrain both themselves and their families while the individualism born of the desire to return to Italy deters them from combining with their fellow-laborers to better their condition. They have in short furnished excellent material for exploitation, whether by landlord, employer, or unscrupulous fellow-countryman.

The effects upon Italy itself have been noteworthy. The money wages of the agricultural laborers who have remained behind have risen, although it is doubtful whether real wages, save in one or two provinces, have increased appreciably. Nor have the returned emigrants improved the agricultural practices. Despite the millions that left the country from 1880 to 1910, the population of Italy increased more rapidly than ever before. This increase, however, was largely secured by the cities, for along with emigration from the country, has gone the characteristic migration within the country from the rural districts to the cities. Dr. Foerster is inclined to believe that emigration has not resulted in a smaller population for Italy as a whole, due to the fact that the excess of births over deaths has increased. This has been caused by the great reduction in the death rate without an appreciable reduction in the birth rate. Of late, however, Dr. Foerster, points out that the birth rate has fallen, notably in Piedmont as a result of the return of the emigrants from France.

Dr. Foerster urges as a program of economic betterment not the encouragement of further emigration, but instead internal reforms. His program includes: (1) the rehabilitation by the government of the agricultural lands of the south by means of reforestation, drainage, irrigation and the construction of roads, (2) the breaking up of the estates into more moderate holdings with the substitution of the cash rental for the metayer system, (3) the introduction of modern farming machinery and practices, (4) the establishment of a universal free system of education. For those who do leave the country, Dr. Foerster would continue the oversight already exercised by the Italian government and would add the establishment of standards which must be met to permit of emigration, the creation of an international labor exchange to adjust seasonal demands for and supplies of labor, the protection of the emigrant while en route and the formulation of a uniform international code defining the rights of aliens.

It is extremely doubtful, however, in the opinion of the reviewer, whether these measures would achieve any permanent gains unless they were accompanied by a thoroughgoing decrease in the birth rate. Dr. Foerster avoids this question but it is one that should be considered in any adequate discussion of Italy's population problem.

Such a reduction in the birth rate would undoubtedly meet with opposition both from the Catholic church and from the imperialists and militarists. The church would object because it has always stood for a maximum increase of its membership. The militarists and imperialists want a surplus population to man the new empires, that they are hoping to stake out in Dalmatia, North Africa and Asia Minor and to form the armies necessary to maintain and enlarge these dominions.

PAUL H. DOUGLAS.

Statistics in Business.—Their Analysis, Charting and Use. By Horace Secrist, Ph.D. New York, The McGraw-Hill Book Co., Inc., 1920. 137 pp.

As stated by the author in his brief preface, this book is intended primarily for the business executive, and with this purpose in mind the treatment is concrete and concise. In the reader's opinion it should prove valuable to the busy executive in suggesting phases of business for scientific study. The material it contains is not mathematical, and can be grasped by persons possessed of little or no knowledge of the scientific aspects of statistics.

The first three chapters, covering forty pages, define and describe the facts of business—any business. We are told how to recognize business facts and where to find available sources. The fourth chapter, under the title of "Classifying and Tabulating the Facts," gives a short and lucid description of the correct and incorrect methods of tabulating statistical data. The author has illustrated the text with several tables and has indicated their good and bad features. Certain fundamental principles are given for the preparation of schedules for the collection of data: (1) Coöperation must be solicited. (2) Inquiries should be brief and to the point. (3) The forms should be simple and not involve an undue amount of labor. (4) The questions should be answerable so far as possible by yes or no or by a simple answer.

After having first shown us how to define and to recognize and then to collect and tabulate our facts, the author in the fifth chapter shows us how to present them in a striking manner by the use of graphs. Rules for charting as well as a description of the various methods and materials used, are treated with sufficient detail as to be a comprehensive survey of the subject. The criticism may be made, however, that often the illustration and the text are not on the same page, making it necessary that the reader turn over several pages when referring to the diagram. This arrangement is not conducive to a close study of the diagrams, and the tendency would be to read the text and casually refer to the illustrations, not giving them the careful attention they deserve.

The closing chapters of this small volume treat the methods of summarizing the results obtained from the tabulating and charting of data. The author devotes some consideration to the discussion of the use and advantages of the average as well as to business principles and standards. In his opinion there are two stages in the application of scientific methods to business or other phenomena: (1) scientific observation and (2) logical inference. It is only by passing through both that a science of business can be developed.

R. L. WHITE.

Vital Statistics: An Introduction to the Science of Demography. By George Chandler Whipple. New York, John Wiley and Sons, 1919. pp. 517.

The outstanding characteristic of Professor Whipple's book is the effective, simple, and forceful way in which the content, and some of the methods, of vital statistics are explained for the benefit of the public health student and the busy health official. Students of the political sciences have for years had the more comprehensive treatise of the late Professor Richmond Mayo-Smith, "Statistics and Sociology," the works of von Mayr, Westergaard, Grotjahn and Kaup, Lexis and many others to guide them, but, with the exception of Dr. Newsholme's "Vital Statistics," an English publication long unobtainable through American book-sellers, the public health student has had no text for study. The lack of such a work may have been responsible for the backward condition until very recently prevailing in the registration and tabular display of vital facts in the United States.

Professor Whipple has wisely discussed his subject in the most elementary manner, and by so doing has made vital statistics attractive to the registrationists and to others in public office who control the collection of the basic facts and the ensuing crude tabulations. These form the building materials out of which the professional analyst, the statistician, erects his structures of induction, and of hypothesis and deduction for the guidance of the statesman. It is not difficult to write a textbook on vital statistics in the necessarily involved philosophical language of interpretive statistics. Professor Whipple could have done that, no doubt; but it would not have filled the need of the hour in vital statistics; he would not have brought home to the ever-increasing number of local registrars the elementary, indispensable criteria of crude descriptive vital statistics. Professor Whipple chose the more difficult task of discussing "first things first."

The first chapter is devoted to a brief history of statistics and of vital statistics, to the uses of crude descriptive data in health administration, and to an elementary discussion of the place of logic in statistics. The two following chapters give practical hints on office technique,—tallying, hand and machine tabulation, table structure, computation of ratios, the use of logarithms and the slide-rule, the seriation of data, and graphic methods.

Enumeration and registration requirements for population statistics, and for births, marriages, divorces and sickness are taken up in Chapter IV. The chief descriptive details of population structure are discussed, and this is followed by two chapters on crude and specific death rates, birth rates, marriage and divorce rates. The nomenclature and classification of diseases causing death are briefly outlined in Chapter VIII. Further comment is given in Chapters X and XI on the crude statistics of mortality from principal diseases and at the several age-divisions of life. A general description of life tables is to be found in Chapter XIV. For methods of computing these tables the student is referred, however, to other works, perhaps inaccessible to the public health official. This is to be regretted because there are elementary methods of compiling abridged life tables,—the Farr method, for instance, which could have been described. The explanation of osculatory interpolation as given by Mr. Burn in his "Vital Statistics Explained" is well within the comprehension of the local registrar who may wish to prepare a life table to show the results of health work.

It is doubtful whether the chapters on "Probability" and "Correlation" should have been included in this elementary work, because it is extremely difficult to teach these subjects to beginners in statistics with any certainty that the methods will not be misunderstood and, consequently, misapplied. This is true especially of measurements of contingency and correlation. As one experienced mathematical analyst has remarked: "Mathematical methods when used by the non-mathematical statistician are as dangerous as a razor in the hands of an infant." The unfinished state of the theory of correlation, the fact that the teaching of the so-called theory of probabilities has not advanced in most of our universities beyond the elements as given in the average high-school or college algebra, the slight attention paid to mathematical-statistical logic in the United States, are sufficient reasons why the newly-introduced student should not be given an opportunity to confound himself with rule-of-thumb "statistical methods." On page 411, Professor Whipple says: "The student will find the use of the coefficient of correlation an admirable weapon for exploding false theories," and as an example, states that a coefficient of correlation of 0.54 between a series of grippe outbreaks in one year and of measles epidemics the next year, is "low correlation." He says: "It follows, therefore, that the statement that grippe is followed by measles a year later has little to substantiate it, if all the facts are considered." A coefficient of 0.54 is by no means "low."

Furthermore, the "correlation" was made from records of only 123 and 184 deaths in the two series, respectively, arranged in twelve pairs and for the state of Connecticut. Would it not have been better to show the need for more data by attaching the "probable error" of this particular coefficient 0.54? Then, again, would it not have been wise to ask for a tabulation of both grippe and measles facts by months instead of by calendar years, over a wider area so that the true periodicity of these diseases could have been shown? Epidemics do not respect artificial calendar year limits. It is not clear why the simpler method of "grade" or "rank" correlation (Spearman's method) was overlooked. Unless the student or public health official or statistician has been disciplined by a sound training and much experience in the basic mathematical studies and in higher statistical analytics and logic, he had better not undertake to support or explode theories of disease relationship and causality. It is much the wiser course to draw extremely reserved, common-sense conclusions from inspection of the crude data, leaving the testing, graduation and logical analysis to the professional statistician.

E. W. Kopf.

Decennial Census of the Commonwealth of Massachusetts, 1915. Taken under the direction of Charles F. Gettemy, Director of the Massachusetts Bureau of Statistics. Boston, Wright and Potter, 1918. Pp. ix+749, with map.

Massachusetts, in successfully taking a census of the population and principal material resources of the Commonwealth in a manner which merits the confidence of the student in the political and social sciences has again succeeded in doing something that no other American state has ever done. It would be idle to designate the states which in 1915 and in prior years failed more or less conspicuously in this important function of government. We can only hope that a sufficient number of the members of this Association in the several states, other than Massachusetts, will take the trouble to inquire, first, why there is no provision for taking an inventory of the human resources of their particular states at times midway between the federal enumerations, and, second, in case there is constitutional or sporadic legislative provision for a state census, why the methods of enumeration and general organization are so grossly defective, and why the published results are inadequate to meet the most elementary needs of state government. A state government cannot afford to fail to provide students of its problems with the most rudimentary facts as to the size of the population and its composition as to citizenship, nativity, color or race, sex, age, civil condition and occupation.

For a text on principles and methods of State Census-taking, inquirers should be referred to Mr. Gettemy's able "general introduction" to the 1915 census volume of his state. After an explanatory note on censuses of the Commonwealth from the earliest times, Mr. Gettemy discusses: purposes and scope of the census; provisions of the 1915 Census Act; organization and personnel of the census; publicity, preparation of schedules and forms, division of the state into enumeration districts, and selection of the field force. The actual enumeration processes and the methods of supervising enumerators' work, preventing fraudulent practices and duplication of enumeration, checking enumerators' errors, etc., are described. In this work of mapping enumeration districts, choosing, instructing and supervising the enumerators, most of the other state censuses fail utterly. The direction of the task of taking a census requires the services of a trained population statistician. Because of the very backward condition of state statistics, such service is rarely, if ever, obtainable from within the state government.

An interesting discussion of the system of card punching, verification and machine tabulation is given on pages 24 to 26.

In addition to a census of "the population and the number of legal voters, in accordance with the requirements of the Constitution, and the collection of such additional information relative to the composition of the population as might be deemed expedient by the Director of the Bureau," a census of fisheries and of commerce, a special investigation on the subject of aged dependents, a list of veterans of the Civil War and a list of blind persons were prepared. The special subjects represented in the many good tables shown in the volume cannot be listed here in full.

The first thirteen tables give information on the total population of the several civil divisions of Massachusetts according to sex, families, dwellings, density of population and housing within various municipal, judicial and congressional districts. The second section, seven parts of Table 14, shows the nativity, color, parentage, literacy, voting age, and general occupation classes of the population. Further elaboration of these elements is given in Tables 15 to 26. Detailed occupation statistics are presented in Tables 27 to 29. The Bureau of the Census classification of occupations, used in compiling the statistics shown in Volume IV, Thirteenth Decennial Census of the United States, was followed in the tabulation of the Massachusetts results. An important difference in the age limits of the federal and state statistics is to be noted. The federal figures for 1910 show occupations of gainfully employed persons ten years of age and over, whereas the Massachusetts 1915 data relate to persons fourteen years of age and over.

Appendix A gives the Act enabling the 1915 Census. The cards upon which the enumerators recorded the population data are shown in facsimile in Appendix E, while Appendix F consists of an historical survey of census taking in Massachusetts. The various methods adopted since 1780 for determining and apportioning the membership of the Commonwealth House of Representatives, the Senate and the Governor's Council are described. A bibliography of Massachusetts censuses concludes the work.

E. W. Kopf.

NOTES

DECREASE IN STATURE; NOTE ON THE MEDICO-ACTUARIAL MORTALITY INVESTIGATION

Some time ago the writer found it necessary to rearrange certain of the data for stature presented in the volumes embodying the results of the Medico-Actuarial Investigations. One of the points considered was that of the post-maximum change in stature.

Powys and Pearson* have treated this subject with great thoroughness on the basis of measurements of criminals from New South Wales. Goring† has analyzed his own data, painstakingly gathered in the British prisons. The Australian data include both men and women; the British returns are for men only.

For comparison I have abstracted the data for men over 24 years of age and for women over 21 years of age from 221,819 insured men and 136,504 insured women recorded by years of age and inches of stature.‡

These lower limits were selected because the data of Powys and Pearson and of Goring indicate that man attains his maximum stature in the age class 25–29 years. In New South Wales woman attains her maximum stature at about 25 years.

At ages earlier than this, stature is increasing with increasing age. At ages later than this, stature is decreasing with increasing age. The rates of pre-maximum increase due to growth and the rates of post-maximum decrease due to shrinkage are of course very different. Pearson and Lee§ attempted to fit algebraical expressions giving the smoothed values of stature for the whole age-range, but found the result unsatisfactory. The results of Powys, Pearson and Goring are consistent in indicating that from the age of maximum stature to old age the decrease in stature with age is as well described by a straight line as by that portion of any curve of a higher order fitted to the data as a whole.

The equations given by Pearson and Goring are:

For fraudulent British convicts, $s = 68.06 - .0341\ a$
For other British convicts, $s = 65.76 - .0133\ a$
For Australian male convicts, $s = 68.34 - .0337\ a$
For Australian female convicts, $s = 63.61 - .0361\ a$

In man the stature decreases from 0.013 to 0.034 inch per year, in woman 0.036 inch per year; both men and women will decrease about one-third of an inch for each 10 years after the age of maximum stature.

The equations deduced from the medico-actuarial data‖ are as follows:

For men, $s = 68.63 - .0030\ a$
For women, $s = 64.94 - .0197\ a$

These equations are represented by the lines in the diagram. The empirical means are given for quinquennial age groups for the Australian and British series, but for each year in the medico-actuarial series.

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* Powys and Pearson, Biometrika, 1901, vol. 1, pp. 38–49.

† Goring, The English Convict, pp. 191–193, 1913.

‡ Medico-Actuarial Mortality Investigations. Compiled and published by the Association of Life Insurance Medical Directors and the Actuarial Society of America, vol. 1, New York, 1912

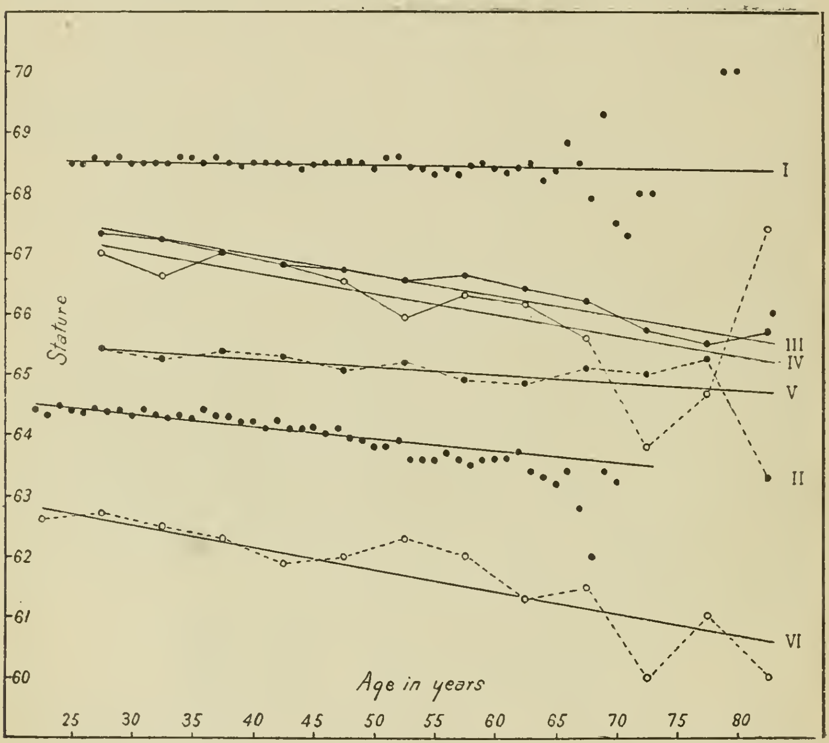
The crudeness of the measurements is frankly admitted by the Committee. Notwithstanding this fact it seems probable that with such large numbers the inaccuracies of the individual measurements will average out, and that the general means will be fairly trustworthy.

§ In memoir by Powys, Biometrika, 1901, *1*, pp. 48–49.

‖ For men, $N = 182{,}290$, for women, $N = 125{,}016$.

The lines and the empirical means for the American series show a clearly marked post-maximum decrease in the stature of the women. This is somewhat smaller than, but otherwise comparable with that found in the British and Australian series.* In the men, however, the decrease in stature is very slight indeed.

The results for these very diverse series are in fair agreement with the exception of those relating to American men. The crudeness of the measurements has already been noted. Again, the data are for insured lives and are therefore a selected class. *A priori* there is no reason to assume that men of 60 years who apply for insurance are of the same social class as men of 20 to 30 years. Among the latter there may be a much larger proportion of recent immigrants or of the first generation from immigrant parents, distinctly differentiated in stature from the older American stock. The medical examiners may have a tendency to refuse policies to the older men who show most clearly marked evidences of senile changes.



I, American men; II, American women; III, New South Wales male criminals; IV, British fraudulent criminals; V, British convicts other than fraudulent; VI, New South Wales female criminals.

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* The means for the women apparently do not lie in a straight line. It is idle, however, to investigate the point farther on the available data.

In view of these facts, little significance is to be attached to the failure of the men in the medico-actuarial series to show a post-maximum shrinkage comparable with that observed in the criminals who were quite involuntary—not voluntary—applicants for measurement, who were not selected after measurement, and who were measured by experts for purposes of later identification instead of by general medical practitioners.

J. Arthur Harris.

SOME LANDMARKS IN THE HISTORY OF VITAL STATISTICS*

In the earlier volumes of the Journal of the Royal Statistical Society—those mines of curious information—a favorite form of contribution was the "tabular résumé," which presented a series of more or less statistical facts on a chronological base. With so distinguished a precedent it has seemed to me that the Quarterly Publications might care to present to its readers a small contribution in the same form, which I have recently drawn up for the use of my students in vital statistics.

This "tabular résumé" attempts to set forth in chronological array what seem to me to be some of the most important landmarks in the history of biostatistics. To disarm in some measure criticisms, which from the standpoint of the professional historian would otherwise be undoubtedly merited, I hasten to say, first, that there has been no slightest thought of encompassing within this short table a complete history of the subject. Historical completeness and the tabular form of presentation do not go well together. The object of the present table is much simpler. It is to get before the student the briefest conspectus of the time relations of the development of the subject on the one hand, and of the personalities concerned in a large path-breaking way in this development, on the other hand. The precise manner in which such an object will be carried out will obviously be different for each person who attempts it. One person's estimate as to the relative historical significance of a particular event or personality will differ from another's. In presenting the matter to my class I endeavor to justify in more detail than is possible in the table itself the particular items which appear. In any event, it seems clear that any historical review of vital statistics would be bound to contain at least a good many of the items of the present table. More than this in the way of agreement among scholars on a historical matter it is doubtless idle to hope for.

In the second place it should be said that if the sources chosen for statement of reference as to the fact are obviously in many cases second-hand, and perhaps somewhat casual, this is so of deliberate purpose. I am hopeful that by so choosing them I may perchance entice an unwary student or so to do a little reading about the men who have helped to develop modern statistics. I am quite sure that this will not happen if I refer him straight off to a ponderous and deadly "Geschichte der Statistik." Nor is there much chance that the embryo health-officer would make anything but very heavy weather if he essayed a voyage into the "*Theorie analytique.*" But if he will read the article in the Encyclopedia Britannica on Laplace he will tend to have a measure of wholesome respect for a great man and will know a little at least of what that man meant in the history of science.

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*Papers from the Department of Biometry and Vital Statistics, School of Hygiene and Public Health Johns Hopkins University, No. 11.

TABULAR REVIEW OF SOME OF THE IMPORTANT EVENTS IN THE HISTORY OF VITAL STATISTICS

Year	Event	Personality Concerned	Authority for Record
1532	First definitely known compilation of weekly bills of mortality in London	——	Hull, C.H., Econ. Writ. of Sir W. Petty, p. lxxxi
1539	Beginning of official registration of baptisms, marriages and deaths in France	——	Faure, F. Hist. Stat. p. 242
1608	Beginning of oldest parish register in Sweden		Arosonius, E. Hist. Stat. p. 537
1662	Publication of first edition of "Natural and Political Observations Mentioned in a following Index, and made upon the Bills of Mortality"	Capt. John Graunt, Citizen of London (1620–1674)	Hull, C. H. Econ. Writ. of Sir Wm. Petty, p. 315
1666	First Census of Canada (The earliest modern census of population)		Godfrey, E. H. Hist. Stat. p. 179
1669	Application of mathematical theory of probability to expectation of human life	Christiaan Huygens (1629–1695)	Stuart, C. A. V. Hist. Stat. p. 430
1693	Publication of "Estimate of the Degrees of Mortality of Mankind," in the Philosophical Transactions of the Royal Society	Halley, the astronomer (1656–1742)	Hull, *Loc cit.* p. lxxvii
1713	Publication of "Physico-theology; or a demonstration of the Being and Attributes of God from his Works of Creation"	Rev. William Derham (1657–1735)	Hull, *Loc. cit.* pp. lxxvii and lxxviii
1718	Publication of the "Doctrine of Chances"	A. DeMoivre (1667–1754)	Art. DeMoivre, Encyc. Brit
1735	Registration of vital statistics begun in Norway		Kiaer, A. N. Hist. Stat. p. 447
1741	Publication of "Die göttliche Ordnung in den Veränderungen des menschlichen Geschlechts aus der Geburt, dem Tode und der Fortpflanzung desselben erwiesen, etc."	Johann Peter Süssmilch (1707–1767)	Hull, *Loc. cit. p.* lxxviii
1746	Publication of the first French tables of mortality under the title "Essai, sur les probabilités de la durée de la vie humaine"	Deparcieux	Faure, F. *Loc. cit.* p. 265
1748	Beginning of Swedish official vital statistics	——	Arosonius, E. Hist. Stat. p. 540
1749	First complete Census of Sweden	——	Rossiter, W. S. Cent. Pop. Growth, p. 2
1753	First Census of population in Austria ordered	——	Meyer, R., Hist. Stat. p. 85
1769	First population Census of Denmark and Norway	——	Jensen, A. Hist. Stat. p. 201
1790	First federal Census of the United States		
1795	First Census of the Netherlands	——	Stuart, C. A. V. Hist. Stat. p. 43
1797	Establishment of Danish-Norwegian Tabulating Office	——	Jensen, A. *Loc. cit.* p. 201
1798	First complete Census of Spain	——	Rossiter, W. S. Cent. Pop. Growth, p. 2
1801	First complete Census of Great Britain	——	Rossiter, W. S. *Loc. cit.*
1801	First complete Census of France	——	Rossiter, W. S. *Loc. cit.*
1805	Formation of first statistical state office within boundaries of German Empire	——	Würzburger, E. Hist. Stat. p. 3
1810	First complete Cenus of Prussia		Rossiter, W. S. *Loc. cit.*
1812	Publication of "Theorie analytique des probabilités"	Pierre Simon Laplace (1749–1827)	Encyc. Brit. Art. Laplace
1812	Inauguration of civil registration of births, marriages and deaths in the Netherlands	——	Stuart, C. A. V. Hist. Stat. p. 432
1812 1826	Publication of "Theoria combinationis observationum erroribus minimis obnoxia" (Least squares)	Karl Friedrich Gauss (1777–1855)	Encyc. Brit. Art. Gauss
1815	First complete Census of Norway	——	Rossiter, W. S. *Loc. cit.*
1815	First complete Census of Saxony	——	Rossiter, W. S. *Loc. cit.*
1816	First complete Census of Baden	——	Rossiter, W. S. *Loc. cit.*
1818	First complete Census of Austria	——	Rossiter, W. S. *Loc. cit.*
1818	First complete Census of Bavaria	——	Rossiter, W. S. *Loc. cit.*
1825	Publication of "Mémoire sur les lois des naissances et de la mortalité à Bruxelles," Quetelet's first statistical paper	Lambert Adolph Jacques Quetelet (1796–1874)	Lottin, Quetelet, p. xx
1826	Establishment of statistical commission in Belgium	Ed. Smits	Julin, A. Hist. Stat. p. 126
1829	First official Census of Belgium	Ed. Smits	Julin, A. Hist. Stat. p. 128

TABULAR REVIEW OF SOME OF THE IMPORTANT EVENTS IN THE HISTORY OF VITAL STATISTICS.—*Concluded*

Year	Event	Personality Concerned	Authority for Record
1832	Publication of "Recherches sur la reproduction et sur la mortalité de l'homme aux different ages et sur la population la Belgique d'apres la recensement de 1829 (premier recueil officiel des documents statistiques)"	Quetelet and Smits	Lottin, *Loc. cit.* p. xxi.
1834	Royal Statistical Society (London) founded	———	Title page of Journal
1835	Publication of "Sur l'homme et le développement de ses facultés, ou Essai de physique sociale"	Lambert Adolphe Jacques Quetelet (1796–1874)	Lottin, *Loc. cit.* p. xxi
1836	First complete Census of Greece	———	Rossiter, W. S. *Loc. cit.*
1837	Civil registration of vital statistics in England. Establishment of office of Registrar-General	———	Baines, A. Hist. Stat. p. 370
1837	Appointment of William Farr as compiler of abstracts in the Registrar-General's Office	William Farr (1807–1883)	Encyc. Brit. Art. Farr.
1838	Publication of "Essay on Probabilities" in Lardner's Encyclopedia	Augustus DeMorgan (1806–1871)	Encyc. Brit. Art. DeMorgan
1839	Organization of American Statistical Association		Hist. of Stat. p. 3
1846	Publication of "Analyse mathematique sur les probabilités des erreurs de situation d'un point." Acad. des Sci. Mem. par div. sav. IIe. Ser. t. ix (Correlation)	A. Bravais	Yule Introd. p. 188
1848	Foundation of the Institute of Actuaries of Great Britain and Ireland		Encyc. Brit. Art. "Actuary"
1860	First complete Census of Switzerland		Rossiter, W. S. *Loc. cit.*
1861	First complete Census of Italy		Rossiter, W. S. *Loc. cit.*
1863	Austria establishes Central Statistical Commission	Count Mercandin	Meyer, R. *Loc. cit.* p.89
1865	Publication of "History of Mathematical Theory of Probability from the Time of Pascal to that of Lagrange"	Isaac Todhunter (1820–1884)	Encyc. Brit. Art. Todhunter
1867	First creation of independent official statistical organization in Hungary		Buday, L. von. Hist. Stat. p. 395
1869	Publication of "Hereditary Genius"	Sir Francis Galton (1822–1907)	Art. Galton Encyc. Brit.
1869	Foundation of Société de statistique de Paris		Title page of Journal
1872	Opening of German Imperial Statistical Office		Würzburger, E. Hist. Stat. p. 337
1881	First general Census of India		Baines, A. Hist. Stat. p. 421
1887	Royal Statistical Society incorporated by Royal Charter		Title page of Journal
1890	First Census in which mechanical methods of tabulation were used	John S. Billings and Herman Hollerith	Rept. Supt. Census 1889, p. 8
1894	Publication of first of "Contributions to the Mathematical Theory of Evolution" in Phil. Trans. Roy. Soc.	Karl Pearson	Title page
1897	Publication of paper "On the Theory of Correlation" in the Jour. Roy. Stat. Soc.	G. Udny Yule	Jour. Roy. Stat. Soc. Vol. LX, p. 812
1897	First Census of Russia	———	Kaufman, A. Hist. Stat. p. 481
1900	First year of separately published official mortality statistics for Registration Area of United States		Title page of "Mortality Statistics"
1901	Publication of first number of Biometrika	Francis Galton Karl Pearson W. F. R. Weldon C. B. Davenport	Title page
1902	Creation of permanent Census Bureau in the United States	———	Cummings, J. Hist. Stat. p. 682
1915	First year of separately published official birth statistics for Registration Area of United States	———	Title page of "Birth Statistics"

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RAYMOND PEARL.

NATIONAL BUREAU OF ECONOMIC RESEARCH, INC.

The National Bureau of Economic Research, Inc., with offices at 175 Ninth Avenue, between 20th and 21st Streets, New York City, has been organized to meet a growing demand for exact and impartial determinations of those facts which bear upon economic, social and industrial problems. While it seeks only to determine facts, its investigations must be carried on in such manner and under such supervision as to make its findings carry conviction to liberals and conservatives alike. For this reason, it is precluded by its Charter from becoming an agency for the profit of its members, directors, or officers, and by rigid provisions in its By-Laws, from becoming an instrument for propaganda. And it assumes no obligation to present or future contributors except to make accurate determinations of facts and to publish the results of its investigations.

The initial investigations of the bureau are expected to deal with the distribution of income in the United States among individuals and by basic sources—wages and other returns for personal service, interest, land rents, and profits in excess of a normal interest rate. A knowledge of this distribution is of vital consequence in the consideration of almost every important political, social, and industrial problem, and will be of particular value in relation to the many questions of taxation, legislation, and industrial readjustment that are now pressing for solution.

In general, the investigations made will deal with topics of national importance, regarding which quantitative analysis is feasible, with the object of placing as much as possible of present-day discussion on a basis of fact, as distinguished from more or less partisan opinion. While the selection of subjects to be investigated in the future rests with the directors, the following problems may be taken to illustrate the probable range of the bureau's activities: The details of excess profits and income taxes, and their economic reactions; changes in the physical productivity of labor under varying conditions of employment; fluctuations in the percentage of idle machinery and unemployed labor; the distribution of property ownership; the relation of the productive capacity of the country to its industrial needs; the relations between demand for goods and prices; selling costs compared with costs in various industries; rates of return necessary to attract investments of capital; the economic effects of immigration; foreign investments of capital in the United States and American investments in foreign countries. It should be emphasized that there is no existing institution today equipped to undertake fundamental researches of the type outlined from a disinterested point of view, whose findings will be generally accepted.

The bureau will, furthermore, be specially equipped to undertake commissions for investigations desired by individuals, corporations or associations, and it is one of its major purposes to afford the means through which such special investigations may be conducted on a basis to assure widespread confidence in the results. Such special investigations must, however, be in line with the general purposes of the bureau and the bureau will reserve in all cases the unrestricted right to publish its findings.

The research work will be carried on by Wesley C. Mitchell, as Director, Wilford I. King, Frederick R. Macaulay, and an adequate staff of investigators and computers. Its management is in the hands of a board of nineteen directors of whom ten are directors at large, and nine directors by appointment.

The initial directors at large are the following:

Edwin F. Gay, formerly Dean of the Harvard Graduate School of Business Administration, and now President and Editor of the *New York Evening Post*.

Wesley C. Mitchell, formerly Professor of Economics at Columbia University, recently in charge of the preparation of a "History of Prices During the War" for the Federal Government, and now Treasurer of the New School for Social Research.

John R. Commons, formerly President of the American Economic Association; also a member of the Industrial Commission of Wisconsin, 1911–1913, and of the Federal Commission on Industrial Relations 1915–1918; and now Professor of Political Economy at the University of Wisconsin.

N. I. Stone, formerly Chief Statistician of the U. S. Tariff Board; later a member of the U. S. Tariff Commission, sent to Germany in 1906; and now Labor Manager for Hickey-Freeman Company of Rochester, N. Y.

Allyn A. Young, formerly President of the American Statistieal Association, now Secretary and Treasurer of the American Economic Association and Professor of Economics and Finance at Cornell University.

John P. Frey, Editor, International Molders' Journal of Cincinnati, Ohio, and prominent in the activities of the American Federation of Labor.

T. S. Adams, formerly a member of the Wisconsin Tax Commission, now Professor of Political Economy at Yale University and Adviser to the U. S. Treasury Department on matters of taxation.

Elwood Mead, formerly Chairman of the State Rivers and Water Supply Commission, of Victoria, Australia, and now Professor of Rural Institutions at the University of California; also Chairman of the Land Settlement Board, and consulting engineer for various irrigation and waterworks companies.

J. E. Sterrett, member of the firm of Price, Waterhouse and Company of New York City, public accountants, and for some time engaged in war and reconstruction service of the U. S. in this country and abroad, and Adviser to the U. S. Treasury Department on matters of taxation.

Harry W. Laidler, Secretary of the Intercollegiate Socialist Society.

Directors at large are elected for five-year terms by the whole body of directors.

In addition, the following organizations have nominated independent directors as follows: Professor David Friday has been appointed by The American Economic Association, Mr. Frederick P. Fish by The National Industrial Conference Board, Mr. Walter R. Ingalls by The Engineering Council, Mr. George E. Roberts by The American Bankers Association, Mr. M. C. Rorty by the American Statistical Association, and Mr. Hugh Frayne by the American Federation of Labor. The other institutions have not yet taken action.

The officers of the Bureau are as follows:

President, Edwin F. Gay
Vice-President, John P. Frey
Director of Research, W. C. Mitchell
Treasurer, M. C. Rorty
Secretary, Oswald W. Knauth

Executive Committee

E. F. Gay, *ex-officio* John P. Frey, *ex-officio*
T. S. Adams J. E. Sterrett
H. W. Laidler

THE CENTRAL STATISTICAL BUREAU OF THE BALTIMORE ALLIANCE

At the beginning of the present year the Baltimore Alliance, a federation of some fourteen organized social or charitable agencies in the City of Baltimore, under the direction of Major Wm. Burnet Wright, Jr., who has recently accepted the post of permanent director of the Alliance, organized a new department of potentially far-reaching importance. It will be known as the Central Statistical Bureau, and will form an integral part of the Alliance. The functions of this bureau are (1) to supervise, standardize, and control the permanent statistical records collected by each of the allied agencies; (2) to serve as the final repository of all case and statistical records; (3) on the basis of the critically controlled basic statistical records to carry on scientific investigations of those broad social problems, towards the ultimate solution of which the activities of the Alliance are directed.

Dr. Raymond Pearl, Head of the Department of Biometry and Vital Statistics in the School of Hygiene and Public Health of Johns Hopkins University, has been appointed Director of the Central Statistical Bureau, and Miss Magdalen H. Burger, formerly chief of the retail price section of the Statistical Division of the United States Food Administration has been appointed Chief Statistician. Funds have been provided for the necessary clerical staff. An advisory statistical committee which is in process of formation, will include among others, Dr. George E. Barnett, Professor of Statistics in Johns Hopkins University, and Dr. W. H. Maltbie, Director of the Bureau of Municipal Research. The bureau will be housed with the Department of Biometry and Vital Statistics of the School of Hygiene, at 625 St. Paul Street, Baltimore.

It is to be expected that with the passage of time there will accumulate in this bureau a set of records which will offer unique opportunities to graduate students and others wishing to undertake fundamental investigations of poverty, disease, and other social problems now retarding community health, well-being and happiness.

BRITISH EMPIRE STATISTICAL CONFERENCE AT LONDON

As early as 1907, the lack of comparability and homogeneity in the statistics of the British Empire was the subject of comment by the Imperial Conference, and in 1913, the "Dominions Royal Commission," a body set up by the conference for the comprehensive study of inter-Imperial economic relations, reported definitely in favor of a meeting of statisticians of the Empire, the object being to reduce, if not eliminate, the differences in statistical method which prevailed between the several units, to level up where possible the gaps and inequalities which existed, and *in fine* to discuss the feasibility of a permanent statistical bureau for the British Empire. Such a bureau, it was considered by the commission, was essential for the maintenance of proper co-ordination and development, and in fact for the creation of a true Imperial statistic. The war postponed action on this recommendation, but it was placed by the Imperial War Conference of 1918 in the forefront of inter-Imperial business to be taken up on the declaration of peace.

The conference duly met in London on January 20, 1920, under the presidency of the U. K. Board of Trade, and sat for a period of six weeks, finishing on February 26. It consisted of representatives of twenty-three departments of the government of the United Kingdom, the chiefs of the central statistical departments of the following self-governing Dominions, namely, Canada, Australia, South Africa and New Zealand, the director of statistics of India, and a representative from each of the following groups of Crown colonies and protectorates: Eastern Colonies, East African Colonies, West African Colonies, West Indian Colonies. The chairman of the Imperial Mineral Resources Bureau was also a representative, and the conference had the advantage of the attendance of various government experts and professional statisticians. Altogether twenty-four sessions of the full conference were held, proceeding for the most part on reports of committees, of which nine were created exclusive of sub-committees.

In addition a meeting was held with the general secretary of the League of Nations to discuss the relations of the contemplated Empire organization of statistics to the plans which are preparing for international statistics.

First place was given by the conference to the consideration of the question of a British Empire Statistical Bureau. The opinion of the conference was unequivocally in favor of the early establishment of such a bureau "for the purpose of obtaining, collating, examining and publishing statistics which bear upon the conditions and resources of the Empire, the common interests of its members and their relations with the rest of the world." Such statistical information, it was suggested, would cover but would not be limited to the following, demography, labor, industrial and general social statistics, production, commerce (foreign and domestic), transport and communication, finance (including currency and banking) and public administration. In order to perform this function efficiently the bureau would in the first instance receive copies of all statistical data prepared within the Empire and suggest such changes from time to time in form and content as would facilitate coördination and insure comprehensiveness, the secondary object being to link together the various central statistical bureaus (or where such do not exist, the larger independent offices), and assist them with advice. Its publications would consist in the main of an annual statistical review of the Empire, with annual or quarterly abstracts of the more important Empire statistics, and periodical monographs on special subjects.

With regard to the constitution of the bureau, the conference recommended that it be incorporated by Royal Charter under the presidency of the Prime Minister of the United Kingdom (as *ex-officio* president of the Imperial Conference), and that it be administered and controlled by a "Council" of members, nominated by the several governments assenting. The practical management of the bureau is to be in the hands of a director ("who should be both an expert statistician and a man of proved administrative and official experience and ability") to be appointed by the Council, in consultation with the governments concerned. For his assistance, an "Advisory Committee" is proposed consisting of members of the Council, the chairman of the Imperial Mineral Resources Bureau and other coöpted occasional members, representing commercial, industrial and financial interests. The suggestion is also made that to provide the necessary professional assistance and at the same time effect a liaison between the Central Bureau and the outlying portions of the Empire, the director should secure certain members of his staff for determinate periods from the staffs of the Indian and Dominion Statistical Offices, by arrangements between himself and the chief statistician of each country, with the consent of the government concerned. Similarly officers of the bureau may be secured for work in the Dominion Offices. It is estimated that the cost of operating such a bureau would be in the neighborhood of $150,000 per year.

Not less important was the series of resolutions passed by the conference dealing with actual statistical procedure. Examination was made of the general field of statistics comprised under the headings above mentioned. Space is available for only the briefest statement of these recommendations:

General.—Resolutions were passed defining in general terms the functions of a statistical office, calling for the publication of all questionnaires, advocating the extension of compulsory powers, and suggesting the improvement of statistical organization in certain Colonies and Protectorates. The report of a special committee making detailed comments and recommendations as to the Blue Books prepared in the various Colonies and Protectorates was adopted.

Trade.—The statistical year, the valuation of imports and exports, the registration of imports and exports by countries, uniform classification, transit and transhipment trade, government stores, parcel post and the format of annual and monthly trade returns, were the subject of special resolutions.

Production.—Twenty-four resolutions were devoted to various aspects of agricultural, fisheries, forestry, mining and manufacturing statistics. Among other recommendations, a quinquennial census of agriculture is called for, and an annual calculation of agricultural values to show (a) the value to the producer, and (b) the commercial value to the country. The resolutions on mining include the following:

"The value of mine products for statistical purposes should be that at the mine itself, regardless of any treatment that the product may undergo after leaving the mine.

"For the purposes of statistics of production, mining production should be distinguished from reduction, smelting and other refining or treatment processes, statistics as to which should be included in statistics of factory production."

Demography.—Twenty resolutions dealt with the population census and with vital and migration statistics. A quinquennial census *de facto,* on an approximately uniform census day, under permanent legislation, was advocated. To the problem of uniform classification and listing of industries and occupations, the conference devoted special attention and reported in considerable detail. Various recommendations as to particulars to be obtained by the census inquiry and the improvement of vital and migration statistics were made.

Prices and Index Numbers.—Perhaps the most important of the seven resolutions passed under this heading had to do with the method of constructing index numbers. It was resolved that the "index-numbers should be so constructed that their comparison for any two dates should express the proportion of the aggregate expenditure on the selected list of representative commodities, in the quantities selected as appropriate, at the one date, to the aggregate expenditure on the same list of commodities, in the same quantities, at the other date." The adjustment of index-numbers to changes in national consumption was also dealt with.

Labor Statistics.—A scheme of labor statistics for the Empire was outlined and a resolution passed advocating that the proposed Imperial Bureau should act, wherever feasible, as medium for transferring such data to any international labor conference, so that the data in question might be available for Empire purposes not later than for general international purposes.

Finance.—The resolutions dealt with budget and debt statistics, income and capital, currency and specie, movements of capital, banking, prices of securities, insurance, and the financial operations of credit institutions in general.

Altogether ninety-seven resolutions were passed by the conference, the effect of which, apart from the specific project of an Empire Bureau, has been to chart a course by which the main statistical activities of the various countries of the Empire may be directed for some time to come. It is proposed that the conference should re-assemble every five years for review of its decisions, and for report, should the proposed Empire Bureau materialize, on the latter's progress and general policy. It may be remarked that the resolutions of the conference were in most cases adopted without dissentient voice and that all its conclusions were arrived at with substantial unanimity. Not least of the benefits already derived have been the establishment of direct personal intercourse between the representatives of the different countries, and the general stimulation imparted to statistical work throughout the Empire. A report of the proceedings and resolutions of the conference has been printed.

R. H. Coats.

THE INADEQUACIES AND NEEDS OF BRITISH STATISTICS

In November, 1919, a petition was submitted to His Majesty's Government setting forth the inadequacies of official statistics for the United Kingdom and the British Empire, and suggesting the appointment of a commission to make an inquiry for the purpose of effecting a reorganization of the existing statistical system. The defects which the petition sets forth briefly and clearly, are of such interest that the petition is presented in full in the following paragraphs. The names of the petitioners are those of a long list of distinguished individuals, and also representatives of various learned bodies and societies, of county and municipal authorities, of medical offices and public health committees, of chambers of commerce, and of various companies and firms.

"1. The undersigned Petitioners desire respectfully to represent to His Majesty's Government the urgent need of a reorganisation of the present system of official statistics as the foundation of a proper system of civil intelligence, in the first place for the United Kingdom, and in the second place for the British Empire.

"2. It is generally recognised by statesmen, publicists, writers and students, that official statistics, as at present collected and published, are inadequate in arrangement and scope for the purposes they should serve, in spite of the efforts and ability of individual official statisticians.

"3. Amongst the causes which have been suggested in different quarters are the following: (i) Absence of any general supervision of national statistics as a whole. (ii) Lack of co-operation between the different departments, except so far as this may be arranged on a voluntary basis. (iii) The fact that compulsory powers are too few and too seldom applied. (iv) Defective supervision of the collection of statistics in some cases, and the employment, especially for census purposes, of persons ill-paid and insufficiently educated and therefore uninterested in the collection. (v) Antiquated and anomalous legislation, such as that which prescribes different financial years for various annual returns. (vi) Inadequate financial provision for the collection of essential statistics.

"4. The attention of the Royal Statistical Society has been called from time to time by some of its officers and members to the imperfection of official statistics. In 1871, Mr. Purdy, one of the Secretaries of the Society, recommended the institution of a central statistical office. In 1907, Sir Charles Dilke, in his Presidential address to the Society, pointed out that there had been little general improvement since 1880 and advocated a permanent statistical control. Similar conclusions were reached in a paper read before the Society in 1916 by one of the Vice-Presidents, Mr. Geoffrey Drage. In June, 1919, the Council of the Society appointed a Committee on Official Statistics consisting of Mr. Geoffrey Drage (Chairman), the Rt. Hon. Herbert Samuel (President of the Society), Dr. A. L. Bowley, Dr. J. C. Stamp, C.B.E., and Mr. A. W. Waterlow King, to press for a Parliamentary inquiry into the whole subject, with general power to act. The result is the present petition, for which, however, the signatories are alone responsible.

"5. The following examples of defects in statistics have been adduced: (i) There is no general information as to wages since the incomplete census of 1906. This census, the census of production in 1907, and the census of population in 1901 and 1911 are not collated, so that there is no definite means of knowing at any date how many wage-earners there are, what they produce, how much they earn and how many people are dependent on them. (ii) There is no information as to the number or income of persons who neither earn wages nor are assessed to income tax, because its collection does not fall within the scope of any existing department, and in consequence the aggregate of national income can only be roughly estimated. (iii) The statistics of home production are very incomplete. In the only census of production of which the report is published, that of 1907, the amounts paid in wages were not obtained. (iv) The railway traffic statistics are so jejune that they are useless either as an index of the trade of the country or for the purpose of international comparison. (v) The trade between England and Ireland is imperfectly known. (vi) There is no official statement of the number of trained seamen in the British mercantile marine. (vii) The number and class of houses available cannot be accurately ascertained from any official publication, nor is there any record of the number of houses built year by year. (viii) Information with regard to consumption of food, clothing and other necessaries is almost entirely wanting. Such illustrations could easily be multiplied. It is almost universally the case that persons engaged in any serious investigation have to rely on roughly approximate estimates in relation to one or more essential factors.

"6. With regard to the Empire similar difficulties occur, though, owing to constant agitation in recent years, some reforms have been secured. It was pointed out to the Dominions Royal Commission of 1912 that there was still a pressing need of (i) a common statistical year, (ii) a common statistical method, including a common method of classification, *e. g.* of metals and textiles, estimation of value and record of the origin and destination of goods, (iii) an annual report of the trade of the Empire on a scale sufficiently large to give adequate details of the trade of the overseas dominions, (iv) some reliable criterion of trade and production and some means of establishing satisfactory comparisons between the productive powers of the several states of the Empire.

"7. Now that the war is over and that there are in the air so many projects of reform both social and commercial, it has become more than ever necessary to provide a system of civil intelligence based on sound statistics which will help to show not only the cost of proposed social reforms, but also the results of changes in our commercial system. It is not too much to say that there is hardly any reform, financial, social or commercial, for which adequate information can be provided with our present machinery, and the same is true with regard to changes that have been proposed in our commercial relations with the overseas dominions and foreign countries.

"8. YOUR PETITIONERS SUBMIT *that the questions raised in this memorial are of sufficient importance to justify an immediate inquiry by a Royal Commission or Parliamentary Committee, and they suggest that such Commission or Committee should forthwith be appointed to inquire into the existing methods of the collection and presentation of public statistics and to report on the means of improvement.*"

PROGRAM FOR NEXT ANNUAL MEETING

A committee, whose names are published in this issue, has been appointed by the President to arrange a program for the next annual meeting. Members of the Association are urged to send to the Secretary's office or to any member of this committee suggestions for papers and discussions. The committee will appreciate the coöperation of members in various fields of statistical work in making the annual meeting interesting to all.

PUBLICATION ON THE CONSTRUCTION OF MORTALITY TABLES

A translation from the Danish of the researches of Mr. Arne Fisher on the construction of mortality tables by means of compound frequency curves is now being made by Mr. Vigfusson. This translation is to be printed through the enterprise of the "Scandinavian Insurance Magazine," and will probably be ready before the end of the year, published by Macmillan Co. The forthcoming volume will contain a number of mortality tables relating to widely different populations, such as Massachusetts males, 1914–1916, American Locomotive Engineers, 1913–1917, American Coal Miners, 1913–1917, Industrial Insured Males of the Metropolitan, 1911–1916, Assured Japanese Lives of fourteen Japanese companies, 1913–1917, and others. These tables are of particular interest as they have been prepared from mortuary records exclusively, and with no knowledge of the number of lives exposed to risk. This method was presented briefly in America in a paper read before the Casualty Actuarial Statistical Society of America, under the title "Note of the Construction of Mortality Tables by means of Compound Frequency Curves," and was presented later in some lectures at the University of Michigan. The novelty of the method has been commented upon with interest, and some appreciative reviews of the proposed scheme have appeared in English, Japanese, Belgian and Swiss statistical periodicals. The forthcoming book will be looked forward to with great interest. A. E. V.

APPOINTMENTS ON COMMITTEES FOR 1920

In addition to those published on the cover of the QUARTERLY, the following appointments have been made:

Committee on Program for next Annual Meeting:
    Wesley C. Mitchell, Chairman
    Robert E. Chaddock
    Earle Clark
    William F. Ogburn
    Warren M. Persons
    George E. Roberts
    Walter F. Willcox
Committee on Fellows:
    Leonard P. Ayres, for five years, to take the place of E. Dana Durand, whose term expired 1919.
The full Committee is constituted as follows:
    Frederick L. Hoffman, term expires 1920
    Adna F. Weber, term expires 1921
    Edward L. Thorndike, term expires 1922
    Carroll W. Doten, Chairman, term expires 1923
    Leonard P. Ayres, term expires 1924
Committee on Nominations:
    Edmund E. Day, Chairman
    Joseph A. Hill
    N. I. Stone
Committee on Business Statistics:
    Malcolm C. Rorty, Chairman
    Willard C. Brinton
    Earle Clark

Edith Miller
Warren M. Persons
Horace Secrist

Committee on Criminal Statistics:
Louis N. Robinson, Chairman
Edith Abbott
Robert H. Gault
Horatio M. Pollock

NEW MEMBERS OF THE AMERICAN STATISTICAL ASSOCIATION ELECTED SINCE FEBRUARY 1, 1920

Altmeyer, A. J., Industrial Commission, Madison, Wis. Chief Statistician of same.

Anderson, George P., Packard Motor Car Co., Detroit, Mich. Charge of special factory statistical reports.

Arnold, LeGrande Jenks, 14 Wall St., New York City. Financial accounting with Thompson & Black.

Atwater, Henry G., American Tel. & Tel. Co., 195 Broadway, New York City. Development and presentation of rates, etc.

Barnard, Chester I., American Tel. & Tel. Co., 195 Broadway, New York City. General charge of research in connection with telephone rates.

Barrow, David F., University of Georgia, Athens, Ga. Teaching mathematics.

Barry, Shepard E., 210 Wisconsin St., Milwaukee, Wis. General Auditor and member of the Office Committee, The Northwestern Mutual Life Ins. Co.

Beckmann, Senta Bertha, 18 E. 41st St., New York City. Supervision of statistics for Writing Paper Mfg. Assn., Tissue Paper Mfg. Assn., Cover Paper Mfg. Assn., and Book Paper Mfg., Associations.

Bennett, Mildred V., 15 E. 40th St., New York City. Manager Dept. Survey & Statistics, Community Service Inc.

Berger, Edla G., Searchlight Library, 450 Fourth Ave., New York City. Member of statistical force employed by the Library in connection with the report of the activities of the Y. M. C. A. in France.

Breitinger, Chas. MacC., 1000 Chestnut St., Philadelphia, Pa. Head of Statistical Dept. of the Philadelphia Electric Co.

Brownrigg, W. G., Room 1114, Arlington Bldg., Washington, D. C. Charge of statistical work, Bureau of War Risk Insurance.

Clarke, Allan V., 120 Broadway, New York City. Asst. to Statistician, International General Electric Co.

Cobb, Margaret V., National Research Council, 1201–16th St., Washington, D. C., Elementary School Intelligence Examination Board.

Comstock, W. Phillips, 910 Michigan Ave., Chicago, Ill. Statistical work of the Continental Casualty Co.

Conant, Luther, Jr., 91 Bacon St., Winchester, Mass.

Correa, Fred B., 817 Standard Oil Bldg., San Francisco, Cal. Sales analysis Standard Oil Company.

Criscuolo, Luigi, Room 3133, 120 Broadway, New York City. Investment banking, analysis of investment securities.

Cross, C. F., 1120 Boston Bldg., Salt Lake City, Utah. Secretary and Actuary of Inter-Mountain Life Ins. Co.

Davis, Frank H., Register Tribune Bldg., Des Moines, Iowa. Actuary, Merchants Life Ins. Co.

Davis, Joseph S., 474 Widener Library, Cambridge, Mass. Teaching and research, Harvard University.

Eames, Fred. M., State Commission of Highways, Albany, N. Y. Assistant Engineer in above Commission.

Fischler, Joseph, 133 W. 23rd St., New York City. Managing Statistician of the Graphic Service Bureau.

Frizell, Arthur Bowes, 38 Harvard St., Worcester, Mass. Instructor in mathematics, Worcester Polytechnic Institute.

Furbush, Edith M., 50 Union Square, New York City. Statistical Department of the National Committee for Mental Hygiene.

Gault, Robert H.; Northwestern University, Evanston, Ill. Professor of Psychology.

Gavett, G. Irving, University of Washington, Seattle, Wash. Teaching mathematics.

Gerdy, Irving, 50 Pine St., New York City. Securities and investment, with Case, Pomeroy &/Co.

Gilman, Stephen, 2626 South Michigan Ave., Chicago, Ill. Member of firm of certified accountants.

Glenzing, William L., Geo. Batten Co. Inc., 381 Fourth Ave., New York City. Advertising, market and merchandising statistics.

Hood, Frazer, Old College, Northwestern University, Evanston, Ill. Professor of Psychology.

Hoopingarner, Newman L., Carnegie Institute of Technology, Pittsburgh, Pa. Bureau of Personnel Research in above.

Hoppock, C. A., 61 Broadway, New York City. Market research work in connection with advertising, with firm of H. K. McCann Co.

Hyde, Duncan C., Harvard University, Cambridge, Mass. Graduate student in economics.

James, Virginia, Bureau of Education and Research, American Red Cross, St. Louis, Mo. Compiling a Handbook of Social Resources for each of the states of the Southwestern Division.

Klein, Philip, American Red Cross, 249 Ivy St., Atlanta, Ga. Director of Activities covering Training for Social Work.

Kimber, Albert W., 52 Broadway, New York City. President of A. W. Kimber & Co., Financial Statisticians.

Kingsland, T. Frazer, 108 Hudson St., New York City. Graphic Control, Borden Company, Charting sales and costs.

Kirkpatrick, Arthur Loomis, 45 William St., New York City. Insurance statistics, Globe Indemnity Co., Casualty Ins.

Loomis, Robert H., 525 Boylston St., Boston, Mass. Asst. Professor of Economics at Boston University, College of Business Administration.

Luce, Franklin H., Union Stock Yards & Transit Co., Chicago, Ill. Compilation of various statistical data gathered from live stock industry.

Mayer, Richard B., 95 Madison Ave., New York City. Statistician, The Blackman Co., Advertising Agency.

Miller, William J., Western Electric Co., Hawthorne Station, Chicago, Ill. Production Supervisor.

Murti Rao, M., Bangalore, South India. Fellow Royal Statistical Society, Statistician, Education Department, Bangalore, South India.

Nichols, Louis M., 120 Broadway, New York City. Chief Statistician, International General Electric Co.

Oberle, William E., 737 Commercial Trust Bldg., Philadelphia, Pa. Presidents Conference Committee, Federal Valuation of Railroads in the United States.

Peck, Paul N., U. S. Bureau of Efficiency, Washington, D. C.

Pierpont, Austen, 130 E. 22nd St., New York City. Dept. of Surveys and Exhibits, Russell Sage Foundation.

Quick, William F., 26 Broadway, New York City. Statistical work for the Annuities and Benefits Committee, Standard Oil Company.

Ramsdell, Leroy A., New York School of Social Work, New York City. Community Organization Assistant and Field Secretary, Atlantic Division, American Red Cross.

Randolph, B. W., 95 Madison Ave., New York City. Director of Commercial Research, The Blackman Co.

Roelse, Harold V., Bureau of Statistics, N. Y. State Industrial Comm., Albany, N. Y. Asst. to Chief, Division of General Statistics.

Ruml, Beardsley, 751 Drexel Bldg., Philadelphia, Pa. Director, The Scott Company Laboratory. Consultant in Personnel Management.

Schmitz, Val A., George Batten Co., 381 Fourth Ave., New York City. Connected with Commercial Research Dept. of above.

Schroll, Luther, Jr., Aniline Dyes & Chemicals Inc., New York City. Preparation of statistical charts and statements.

Shelton, W. Arthur, Bureau of Statistics, Interstate Commerce Comm., Washington, D. C. Statistical research for above.

Sibley, John L., 80 Maiden Lane, New York City. Charge of Statistical Dept. United States Casualty Co.

Simon, Leon Gilbert, 120 Broadway, New York City. Research work in insurance statistics.

Stannard, J. W., American Autoparts Co., Detroit, Mich. Financial work in above company and American Steel Foundries, Chicago, Ill.

Stellwagen, Herbert P., American Tel. & Tel. Co., 195 Broadway, New York City. Accounting Dept. and Statistical Division.

Stevens, Edwin B., University of Washington, Seattle, Wash. Executive Secretary of University.

Stevenson, T. Kennedy, Western Electric Co. Inc., 195 Broadway, New York City. Sales statistician.

Stewart, Walter W., Amherst College, Amherst, Mass. Professor of Economics.

Thurstone, Louis L., Carnegie Institute of Technology, Pittsburgh, Pa. Teaching Psychology, Statistics and Mental Test Technique.

Tryon, Frederick G., U. S. Geological Survey, Washington, D. C. Division of Mineral Resources. Charge of Coal and Coke Statistics.

Valentine, Frederic, American Tel. & Tel. Co., 195 Broadway, New York City. Rate Research.

von Huhn, R., 25 Broad St., New York City. Statistical Dept., William Salomon & Co.

Weyforth, Wm. O., Johns Hopkins University, Baltimore, Md. Teaching Business and Social Statistics.

Williams, E. P., 1507 Mallers Bldg., Chicago, Ill. Bureau of Market Analysis Inc.

Wolfe, French E., Syracuse University, Syracuse, N. Y.

A CORRECTION.

At the 81st Annual Meeting of the Association, the Proceedings of which were published in the March QUARTERLY of this year, the death of one of our honorary members, Dr. Louis Guillaume, Berne, Switzerland, was announced. We are glad to inform our readers that this was an error, and we express regret for the mistake.

NEW SERIES, NO. 130 (VOL. XVII) SEPTEMBER, 1920

QUARTERLY PUBLICATION OF THE

AMERICAN STATISTICAL ASSOCIATION

THE CLASSIFICATION OF THE STATISTICAL EMPLOYEES OF THE UNITED STATES GOVERNMENT AT WASHINGTON

By Lewis Meriam,[*] *Institute for Government Research*

The nature of any classification must depend on the purposes to be achieved through its use, and accordingly in discussing the work of the Congressional Joint Commission on Reclassification of Salaries in respect to the statistical employees of the government at Washington, it is desirable to begin with a statement of what the commission sought to accomplish, in so far as one may justly attempt to formulate purposes of a commission.

The immediate object of the commission can perhaps be best set forth by quoting a paragraph from the act of Congress creating it:

> "It shall be the duty of the commission to investigate the rates of compensation paid to civilian employees by the municipal government and the various executive departments and other governmental establishments in the District of Columbia, except the Navy Yard and the Postal Service, and report by bill or otherwise, as soon as practicable, what reclassification and readjustment of compensation should be made so as to provide uniform and equitable pay for the same character of employment throughout the District of Columbia in the services enumerated."

Persons familiar with the government service will at once appreciate that such an authorization from Congress permitted of two courses. The commission might submit a report that would permit of a temporary realignment of salaries without attempting to correct those forces which have produced the existing evil conditions. On the other hand, it might recognize the dynamic nature of the problem of handling a force of over 100,000 employees engaged in hundreds of diverse undertakings; and it might attempt to devise a continuing mechanism to preserve a permanent, uniform and equitable alignment in salaries and to correct those forces that have caused conditions of employment in the government service to become notorious. It could have given a narcotic to remove the symptoms, or it could have attempted to map out a régime of right living that would ultimately eradicate the causes.

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[*] Late Chairman of the Staff Committees for the Classification of Statistical Employees, Congressional Joint Commission on Reclassification of Salaries, and Statistician to the Commission.

The commission never hesitated in its choice. Whatever criticism may be leveled at the commission's work, it can never be fairly said that the commissioners did not broadly interpret their responsibilities, that they did not welcome suggestions and advice from every person who thought he had something to contribute to the success of the undertaking, or that they sought to save themselves work. Broad interpretation of their responsibilities, democracy in organization and management, a willingness to listen, though undoubtedly with more than two members, figuratively, from Missouri, and a tendency to be constantly on the job, were the dominating characteristics of the commissioners. They sought to achieve a broad fundamental reform in the methods of employment management in the civil service.

This fundamental decision necessarily exerted a profound influence on the classification they developed. Had the commissioners taken the narrow view or sought to avoid work, they could easily have established a comparatively small number of salary grades and assigned each position to one of these grades. In other words, they could have duplicated the classification processes that were applied about the middle of the last century. They might have gone a little further than that and have attempted to write out for each salary grade a statement of the duties and responsibilities which would justify placing an employee in this grade. Such definitions would have been of the blunderbuss variety and would have lumped together employees doing things which were very unlike, but which were believed to be of equal value to the government. This course would have had the great merit of apparent simplicity, but it would have been of comparatively little aid in achieving the fundamental reforms that the commission determined were necessary.

To make a complete enumeration of all the detailed objects to be secured through the application of the classification is doubtless beyond the power of any one observer, but some of the more important ones can be discussed.

For the purposes of recruiting suitable employees for the service, it has long been felt that more specific tests of qualifications could be given. To give specific tests of a candidate's qualifications for a particular craft or line of work, it is first necessary to know what qualifications a person must possess to perform those duties satisfactorily. That is almost painfully obvious, and, of course, the Civil Service Commission has known it; but it has not had the funds and equipment to make a study of the entrance qualifications necessary for the individual positions or to give more minute examinations designed specifically to test for those qualifications. It has given for many positions broad, general examinations, testing an employee's general education and ability; but it has not found whether the employee has the ability, knack, or inclination that leads to success in the particular job. The Reclassification Commission designed a form of classification that would ultimately lead to the formulation of a statement of the specific requirements for the particular jobs. It made a preliminary statement of the required entrance qualifications, a mere beginning. Experience will modify and perfect these statements, but it was believed that a good classification of positions, to be of service for recruiting, must possess an analysis of the requisite qualifications.

Similarly, the commission sought to develop a classification that would be useful in regulating promotion. It made a vital distinction, not now generally recognized in the federal service, between an advance in salary not accompanied by any increase in duties or responsibilities, and a promotion, meaning a change to more difficult work or the assumption of greater responsibilities. How vital a matter this distinction is can hardly be appreciated by one who has not been in a government bureau with a "statutory roll," that is, with an appropriation which specifies the number of employees to be hired at each of the specified rates of pay. In such a bureau, no employee can secure increased compensation unless there is a vacancy to which he can be advanced. When the vacancy occurs, the administrator frequently is called upon to make a choice between the employee who merits an advance in pay on the basis of meritorious performance of unchanged duties and the employee who deserves promotion because of increased duties and responsibilities. He must choose, and as a result, through the continued application of such choices, it not unfrequently happens that almost all relationship between pay and duties is lost and longevity is the real factor that determines the position on the pay-roll.

This situation the commission desired to eliminate, and consequently it recommended a classification in which advancement in pay while performing a specified class of duties, involving specified responsibilities would be semi-automatic upon demonstrated efficiency and not contingent upon the existence of a vacancy. Such semi-automatic increases must necessarily be within reasonably narrow limits, and thus a fairly minute classification was essential.

Promotion in the federal service at Washington at the present time is virtually free from any centralized control or regulation. The Civil Service Commission intervenes, practically speaking, only in so far as it is necessary to preserve the integrity of its entrance examinations, by blocking the obvious device of getting a person into the service on a low grade examination and then promoting him to a higher position. Further than this it does not go, and the selection for promotion rests virtually in the hands of the appointing officer, subject only to such restrictions as may have been placed round him by Congress in its appropriations. In administering a statutory roll, he can promote or advance an employee only when he has a vacancy, and generally speaking he can have only such a number of employees and at such rates of pay as have been specifically authorized. In administering a lump sum roll, he can have as many employees at such rates as he desires, provided the aggregate expenditure does not exceed his appropriation and provided he does not exceed any maximum limitations that may be placed upon the appropriation in respect to the salaries to be paid. One man can promote or advance at will, the other finds his hands tied.

Selection for promotion, when one may be made, is not formally competitive. The Reclassification Commisssion sought to introduce in so far as possible the competitive element. Formal set promotion examinations of the traditional type are, of course, universally viewed with suspicion, but an impartial review of the records of the candidates by an outside examiner, supplemented by such practical tests as can be devised, is probably necessary to eliminate improper influences affecting promotion. The hope of the day for successful control over promotions is the record of efficiency and adaptability displayed in the daily performance of the duties of the job.

A very little work with efficiency records will convince one that the first step in their development is a fairly minute analysis of the duties of the job. Reliable statistics of productiveness and accuracy may be kept for the routine card punch operator, and one may get very good numerical data on a group of statistical clerks doing such simple tasks as straight copying and computing. As the higher groups of statistical clerks are reached, numerical records of efficiency break down and one has to depend on a general analysis of the product and the record. If any progress is to be made with the development of records of productiveness and the general value of employees as a means of determining those to be promoted and advanced, the classification of positions must be fairly minute on the basis of the craft being followed by the employee.

Another factor that influenced the commission toward the development of a fairly minute classification upon the basis of the craft followed was the desire to promote the development of the employee. At present the problem of training and developing employees is very largely in the hands of the supervising officer in immediate charge of getting out the work, and frequently in a given office the number of employees following a given craft is so small that any formal training for them is out of the question. They get what the job gives. If these isolated employees are classified by craft and the figures for the craft are brought together, regardless of organization lines, the figures become impressive. Can an employer of 10,000 filing clerks, scattered through many orgaization units, safely afford to leave the training and development of filing clerks to the individual units? What are the possibilities for training statistical employees at Washington, with the total number in the different branches of the work in the neighborhood of 3,243, not counting the temporary employees of the census?

The commission was impressed with the possibility of opening careers for employees in the civil service. At present the horizon of the government employee generally lies within the confines of the bureau or office to which he is first appointed, and sometimes even within the division or section of that organization. He gets in training and development as much or as little as his bureau or office has to offer; and at times he is called upon to abandon one craft he has learned and pick up another, because the work of his unit has changed or because it offers no opportunity for higher work in the craft he has learned. That he has a talent, say, for statistical work, and that the government as a whole needs employees qualified for that work, is not the vital question. Does his office need it? If not, then he must do something else or fight the system. The present system actually opposes movement from one department to another, and he who would change must have knowledge of other organizations, perseverance, and a pleasing personality or else "influence" that will win him consideration where he wishes to go, and then if he has served his three years in the department or independent establishment to which he was first appointed, he may be transferred.

The modern conception that people must be tried out a bit, so that each peg may ultimately find an appropriate hole, is absolutely contrary to the government practice. The new man works in the office to which he is assigned, and if he is a misfit—well, he is a misfit. Private organizations pursuing this employment policy "fire" the misfits, which after all is far better for the misfits than the government practice of keeping them. After a man has been a misfit around a government office for a few years, he is in the "dead wood" class. Presumably he had some good in him when appointed, at least he was good enough to get by the civil service, and that is something; but being a misfit breaks his spirit, and by the time his three years are up his main interest is pay day, if it is not in cultivating a little congressional influence.

The commission believes thoroughly in eliminating persons who do not make good, but it believes first in giving them a real trial. For this reason, it recommends an employment policy which would tend to belittle organization lines. The Civil Service Commission would be required to follow the employees, and if they were not coming up to requirements, to make a diagnosis of the case and to replace them. The employee would be free to go to the commission if he were dissatisfied with his own situation, and to have its aid and assistance in working out his future. If he is statistically inclined and has absorbed all that the Indian Office has to offer in the way of possibilities of statistics, the commission can place him in the Census or in Labor Statistics or in any other office that needs that kind of work and is looking for persons who are anxious to do it. For work of this type, a classification by crafts is distinctly helpful.

The existing congressional opposition to transfers from one department to another is born of the absence of any standard salary rates. Not infrequently one department will pay an entrance salary as much as 50 per cent more than another for the same work. The eligible person passing a given civil service examination with the highest rating may be certified to a low paying department and may accept. A few months later a high paying department may call for a certification from the same register and get a candidate who just did pass. When the first employee discovers that another department is paying much more to others who are not so well qualified, he naturally would like to "transfer." Such a condition gave rise to the "transfer evil," and the administrators who were operating their offices on a low salary scale appealed to the congressional committees. Sometimes they used the situation as an argument for larger appropriations to enable them to meet the salaries paid by the other organizations, and at other times they merely complained against the raids that carried off their employees. The quick, direct solution was to limit transfers. If a standard salary scale were in use, this objection to transfer would be entirely eliminated.

In a cursory way this discussion has indicated some of the motives which led the commission to discard the proposal for the establishment of a few descriptive salary grades, and to develop instead a detailed classification with a division into crafts, and into classes within crafts according to the logical divisions into which crafts may be divided by persons who are familiar with them, or who have made a detailed study of them.

The actual division into crafts and into classes within the crafts was made by the so-called "detailed" staff of the commission, men and women from the government offices selected because of their knowledge of the type of work with which they were to deal and their familiarity with the government service. They were under the leadership of a "headquarters staff" of industrial engineers experienced in personnel classification, the two principal members of which were Mr. E. O. Griffenhagen, chief counselor, and Mr. H. E. Fleming, director.

Perhaps it may not be improper to say that many of the members of the detailed staff entertained a profound hope of a possible result from the detailed specifications over which they labored so many months, examining hundreds of questionnaires, writing and revising specifications, conferring with their associates in the commission, in the departments and offices, and on the numerous advisory committees—wherever they could get enlightenment and assistance. They knew that the classification was not inseparable from budgetary reform, and they recognized the wisdom of the commission in not linking its fate to any particular budgetary legislation. The fact still remained that the item of "personal services" is one of the heaviest among government expenditures; and that although reclassification can proceed without a budget, a budget cannot get anywhere without going into the matter of salaries and salary standardization. The detailed employees were many of them practical administrators of no little experience, and collectively they knew the game. They entertained the hope that through reclassification, under a detailed, precise set of specifications, might come a better understanding between the executive establishment on the one hand and Congress on the other. They saw in this detailed book of job specifications the compromise method for appropriating for personal services, which would give to the administrators that freedom which comes from a "lump sum" appropriation while it preserved to Congress that element of control that is characteristic of a statutory appropriation.

Individual cases of abuses of lump sum appropriations in some of the war agencies, the payment of salaries out of all proportion to anything in the old establishments, made vivid the danger of uncontrolled lump sum appropriations. On the other hand, many knew from experience the difficulty of forecasting twenty-three months in advance the exact services which would be required for a bureau or division, as is necessary under a statutory roll. Frequently there are sufficient funds, but the money is so tied up that the responsible administrator is prevented from achieving the best results. The possibility afforded by the detailed specifications was that the administrators could say to Congress: "Give us the money you think wise, control us in respect to the salaries we may pay through these detailed minute specifications which you may alter from time to time to keep us abreast of the changes in economic conditions, but leave us free to adjust our numbers and the exact disposition of our forces within these detailed specifications. Require us to estimate in advance according to the standard specifications and to report in detail in accordance with them, but give us a little freedom for adjustment." A broad set of descriptive salary grades would offer many possibilities for evasion. The detailed specifications as drafted would give to Congress a control over the actual expenditures for a given type of service that it has never yet achieved. It has in fact controlled the amount paid, but it has never determined the quality and quantity of the article purchased. This classification was designed to give to Congress detailed control over what it gets for the money spent for services.

Such are the broad objects of the classification, almost all demanding a scientific division into primary units or classes, as distinguished from a grouping of such true classes as are believed entitled to like salaries into non-homogeneous grades. Statisticians need hardly be reminded that given true classes, grouping into grades is simple enough, but to unscramble a non-homogeneous grade where the component classes are not shown necessitates doing much of the work over again.

The statistical positions in the classification are divided into three services: the statistical science service proper, the statistical clerical service, and the mechanical tabulation service.

In the statistical science service are placed those positions in which the employee is required to analyze economic, social, or related problems, to develop or to apply statistical methods in their solution or illumination, and to interpret the numerical data pertaining to the subject. A prerequisite for entrance into this service is a fairly broad familiarity with current economic and social problems and with the methods of research in these fields, which is, of course, now ordinarily secured through college and university training with some specialization in the social sciences. For the higher positions in this service, thorough knowledge of the special subject and practical experience are required, but all the positions have the common characteristic of requiring a sufficient background of knowledge and a sufficient familiarity with the methods of social research to enable the incumbent to make analyses, perhaps very elementary ones, and to interpret data in the social field, using the term "social" broadly.

The statistical clerical service includes those positions which require the supervision or performance of the clerical processes involved in the collection, tabulation, and interpretation of statistical data, exclusive of positions concerned entirely with the operation of the mechanical tabulating machines and the processes incidental thereto. The most common clerical processes involved are the collecting and examining of schedules and their preparation for tabulation, tabulation and computing, and the verifying of these processes. The upper classes in this service include the supervisory statistical clerical positions, and require successful experience in statistical clerical work and no little administrative ability, and in salary grade they outrank the lower positions in the statistical science service. They are distinguishable from the positions in the statistical science service in that they do not involve the determination of the nature and scope of the inquiry, its scientific content, or the interpretation of the results. If these duties are involved, the position goes into the statistical science service, even if the duties of the position include the supervision or the actual performance of some statistical clerical processes. The basic educational qualifications for first entrance into the statistical clerical service are: "Training equivalent to that represented by graduation from high school or from a commercial school of recognized standing, neatness in preparing papers, legible penmanship, and rapidity and accuracy in arithmetic, writing and figure copying." With these fundamental qualifications, a person may ordinarily be developed into a journeyman statistical clerk and, if possessed of administrative ability, may become qualified through experience for the highest statistical clerical positions.

The mechanical tabulation service includes those positions requiring the supervision or performance of work required in the mechanical tabulation processes, exclusively. "Exclusively" is used because if a statistical clerk incidentally operates mechanical tabulating machines as one of the parts of his general statistical clerical work, he is classed as a statistical clerk; and similarly, if a statistical scientist occasionally designs a punch card or a code, or runs a tabulator, or supervises a mechanical tabulation unit, he is still placed in the statistical science service. The highest classes in the mechanical tabulation service embrace the positions involving the supervision of important mechanical tabulation organizations, including the "laying out" of the work, the designing of cards and codes. In salary rank they may be on a par with the higher statistical clerical classes and they may be above several classes of the statistical science service. For entrance into the lower classes of this service, the educational qualification is a common school education.

"The line of normal advancement," one will at once observe, has been an important factor in influencing the classification. An intelligent person with only a common school education, entering the service as an operator of one of the mechanical tabulating machines, can from his or her office experience generally acquire the qualifications requisite for the higher positions in the service. Similarly, a person with an education equivalent to that gained in a high school can, by virtue of his or her experience alone, advance to the higher positions in the statistical clerical service. The employee in the mechanical tabulation service who has only a common school education, and the statistical clerk who has gone no further than the high school, according to this classification, are required, if they desire to go ahead along the less normal course of advancement, to supplement the development that they are getting in the every-day routine of the position by study and work that will make up for the qualifications which they lack.

The commissioners, it should be noted, were by no means sticklers for academic degrees. "Training equivalent to that represented by" was the standard phrase without which it was not permitted to specify even graduation from high school, not to mention college, and the bill submitted by the commission provided that:

> "(d) Whenever the possession of a university or college degree or a high-school diploma, or the equivalent of such degree or diploma, is prescribed as a qualification for a class, the commission [to administer the act] shall prescribe as such equivalent a standard, or standards, based on experience or demonstrated ability in the performance of duties similar to those prescribed for such class, which will be accepted as such equivalent."

The intention of the commission was to be eminently practical in the matter, and the educational requirements such as graduation from a high school, or college, or three years graduate study, were used not as arbitrary requirements but as convenient, easily-expressed measuring sticks. If a statistical clerk who has been working for years with statistics of industry wished to qualify as a statistician in that field, he would be examined not in Greek, and Latin, and ancient history to discover whether he had the equivalent of a college education, but on his knowledge of the economics of industry and on his ability to plan the scope and content of inquiries, to analyze statistics and write reports. The absence of a college education would raise a rebuttable presumption against him which would necessitate his satisfying the Civil Service Commission that he had acquired the really requisite education and knowledge in his own way. If three years graduate study was mentioned as the measure, the candidate would be expected to show not only a good general knowledge of his subject, but such an ability to make contributions to it as might have won him his doctor's degree if he had followed orthodox academic educational lines.

The commission was alive to the unique possibilities for the training and development of employees for technical and scientific positions that are inherent in the government service. Time did not permit the development of a detailed plan for supplementing the work of existing educational agencies in the District of Columbia, which are already rendering a noteworthy service in adapting their hours and to a limited extent their courses to meet the needs of the goverment employees, but the commission recognized the duty of formulating and executing such a plan as a necessary function of an effective administrative agency concerned with the employment problem of the United States government. The establishment in the government service of a deliberate system for the training of statisticians and statistical clerks would be a great step in advance. Many statisticians in private employment have acquired much of their preliminary training and experience in the public service, and they will appreciate the fact that with only a little deliberate thought and effort this experience might have been made far richer and broader. A governmental training system would, as a matter of fact, advance the profession as a whole and would benefit all users of statistics by raising the quality of the figures.

Administration was not recognized as a distinct craft. Positions involving administrative duties, as a rule, constitute or are included in the upper classes of that special service which differentiates and gives character to the administrative office being classified. Thus the position of director of the census constitutes a "one man" class in the Statistical Science Service and not a position in a Bureau Chief Service. In its classification, the commission takes the obvious position that a director of the census should be at once a statistician and an administrator, and, similarly, that senior statisticians directing large statistical undertakings should be both statisticians and administrators.

The commission, however, did not go on record as favoring the placing within the competitive classified civil service the positions of bureau chief and other similar offices that are now filled by the President, either with or without the consent of the Senate. Its bill specifically preserves the status quo established under the Civil Service Act of 1883. The provision recommended reads as follows:

> "*Provided further,* That the President may make an appointment to a position excepted from the provisions of the Civil Service Act, or exempted from examination thereunder, without regard to the qualifications specified in the classification of 1920 or the provisions of this Act relating to appointments to a position, or such rules and regulations as may be adopted thereunder; but nothing herein contained shall prevent the President, as provided by the Civil Service Act, from including such position

within the provisions of such Act or from terminating the exemption from examination with respect to such position, and thereafter such position shall be subject to all the provisions of this Act."

Legally, therefore, its carefully drawn specifications for the high positions that are now outside the competitive classified service would have the value of waste paper. What their moral value may be remains to be seen. Conceivably, they might have a powerful influence on the President in making his nominations, and on the Senate in passing upon those nominations. Whenever Congress is ready to remove all non-political offices from politics, moreover, the classification is ready to meet the situation. Ardent champions of civil service reform will find in this feature of the commission's report its most outstanding departure from sound principles of personnel administration. The answer to their criticism will have to be found in political expediency, and it will have to be admitted that the object of opening up possibilities for successful careers in the public service found a limit in political expediency.

The higher classes in the statistical science service and to a lesser extent in the statistical clerical and the mechanical tabulation services, are what the commission terms "group classes" as distinguished from "true classes." They are groups of classes which have common characteristics in respect to general duties and responsibilities, but which differ from each other in respect to the subject matter involved. Under the group class title "Senior Statistician" one will find, as illustrative specific titles, "Senior Statistician (Population), Senior Statistician (Transportation), and Senior Statistician (Vital Statistics)," and in addition to the statement of common qualifications demanded, the added requirement, "For each class in the group, specialization in training and experience in the subject matter to be dealt with in the position concerned as indicated in the title of that class."

In the lower classes of the statistical services, the employees are to a very considerable extent interchangeable, and one with good statistical clerical ability is equally serviceable whether working on vital statistics or on statistics of foreign trade; and the recent college graduate with good fundamental training in the social services can perhaps do almost equally good work in any one of a number of different bureaus. As the employee continues to serve in a given bureau, he acquires a highly specialized knowledge of the subject matter with which his bureau deals. That is obviously the case with statisticians, for they must, to be successful, know both method and subject. In a lesser degree it is true of clerks. The high-class statistical clerk is sometimes distinguishable from his lower-class fellow worker mainly because of his clerical knowledge of the subject matter or of the procedure. He may have a precise detailed knowledge of a complex classification that makes him almost invaluable, or he may know the routine procedure as no one else knows it. This knowledge is to be distinguished from that of the statistical scientist in that the clerical knowledge would not fit an employee to throw existing classifications and procedures into the discard, and to develop new ones that would make the statistics more closely related to life. The clerk must know that a certain method of procedure is to be followed, whereas the statistical scientist must know *why* it is to be followed, and especially what social good is to be achieved. In passing, it may perhaps be remarked that failure to distinguish between these two types of knowledge in the selection of employees for important governmental statistical positions has resulted in some instances in keeping the governmental statistical output in certain important and dynamic fields practically unchanged over periods of thirty or forty years, and, as a consequence, the figures are of little practical use in illuminating current economic and social problems.

In the upper classes of the statistical services, the possession of the knowledge needed in the position is included in the entrance qualifications. To a very considerable extent such a requirement gives to the employee already in a bureau or an office an advantage over his competitors who would seek to transfer to that bureau or office from an office dealing with a different subject matter or procedure, and thus it possibly results in some narrowing of the opportunities for advancement, especially for employees in offices that are dealing with a subject that is peculiar to that individual office. If an employee wishes to change his line of work, he may find that it is necessary to accept a position in the office in which he wishes to serve lower in class than the position he has been filling in the old establishment.

Some difference of opinion exists as to the seriousness of this interference with free competition without reference to organization units or lines. My own experience has been that the value of a statistical clerk frequently turns quite as much on his grasp of the subject he is working with and on his knowledge of the office and its procedure as it does on his possession of those qualities common to all statistical clerks. The popular tendency in the past generally has been seriously to underrate the amount of peculiar and specialized knowledge that a government clerk must possess to fill the higher clerical positions in the public service. The upper government clerks are in fact often specialists. The inclusion of knowledge of the subject and the procedure as a requisite qualification for the positions recognizes this fact. The resulting preference thereby given an employee of the office in competition with those outside it, leaves room, moreover, for the deliberate development of the understudy system in management. My own judgment has been that these factors far outweigh any objection that comes from narrowing the competition for a vacancy by demanding knowledge of the subject.

The use of group classes to cover positions that involve like responsibilities and duties, but call for a knowledge of different subjects or procedures, is feasible only if the decision is reached not to differentiate in salary on the basis of the subject or procedure known, provided these factors call for approximately equivalent training, experience, and ability. Persons familiar with the government service as it exists today are aware that a decision not to differentiate on this basis represents a radical reform. In certain fields of statistical investigation and research, the government is a monopolistic employer. Nobody is competing with the government for men to conduct nation-wide censuses of population, nor is the competition keen for men trained in vital statistics or educational statistics. On the other hand, the government has had to meet serious competition for men trained in the field of commercial statistics. Partly because of this competition, partly because of the difference between lump sum and statutory rolls, and partly because of differences in the market when the positions were established, great inequalities in salaries have arisen, and a chief statistician in a field where the government is a monopolistic employer has had to rest content with a salary much less than that being paid to chief statisticians in competitive fields. As an almost inevitable consequence, the younger men who are in a position to change more easily are turning toward the better paid fields, and one can perhaps properly question where the government is to get its future broad-guaged men for its monopolistic positions, in spite of the fact that some of these offices afford an almost unique opportunity for public service.

The commission met this situation by a decision not to let the degree of outside competition or the size of outside salaries be the determining factor. It placed scientific and technical positions regarded as demanding men of equal training and experience on a like salary scale and would pay its vital statisticians salaries equal to those paid its commercial statisticians. In view of this decision group classes could be used.

Another significant feature of the classification of statistical scientists is that both research statisticians and administrative statisticians are placed in the same class. The qualifications for Senior statisticians, for example, contain the following alternative requirement: "successful experience in the organization and management of important statistical inquiries and investigations, including the determination of the scope of the inquiry, the content of tables, the methods of analysis, and the preparation of reports, or distinction achieved in independent research in the subject to be investigated, or in closely related subjects, as shown by writings and publications and reviews of them."

Conceivably, the time may come when the number of statisticians is so great that the government will be able to secure, for those important statistical undertakings which involve administration, persons who are at once both good administrators and research statisticians of distinction. For the present, the wiser course seemed to be not to establish classes for these super-men of the profession, but to give equal recognition to those who can qualify under either one of the two branches. At present, the large statistical projects of the government must be organized about the available men; and he who is strong on one side and weak on the other must be buttressed on his weak side by capable assistants. The important thing now is to prevent administrative statistical positions from being filled by persons who are not statisticians at all.

The titles of the different classes recommended by the commission, with the salaries it would pay, are given in the following table. The detailed specifications descriptive of the duties, qualifications, and lines of advancement extend from pages 815 to 831, inclusive, of the commission's report and are, therefore, too long for reproduction here.

The position of director of the census and the class of positions entitled Senior Statistician, it will be noted, carry three asterisks in place of a recommended salary. The three asterisks indicate that the rate of compensation shall be "recommended to Congress by the Civil Service Commission after consultation with the heads of departments or independent establishments concerned. The recommendation shall be based upon a full appraisal of the duties and responsibilities of the position and its relation to positions in similar classes; the rate of compensation in each such case to be determined by Congress."

The commission appreciated the fact that in these highest positions the man makes the job. Inferentially, the lowest salary for a Senior Statistician would be over $5,040, since the general rule of the commission was to make the entrance salary higher than the maximum salary for the class below. The commission would perhaps have been willing to fix a minimum, but it was not ready to fix a maximum or to provide for automatic advancement for the highest classes.

The salaries for the statistical science service as a whole are like those recommended for corresponding classes in the other technical and scientific services such as the engineering service, the biological science

Title	*Annual Salary*					
Mechanical Tabulation:						
Assorting Machine Operator	$1140	$1200	$1260	$1320		
Tabulating Machine Operator	1200	1260	1320			
General Tabulating Machine Operator	1560	1620	1680			
Supervisor, Tabulating or Assorting Machine Section (Group)	1560	1620	1680			
Mechanical Tabulation Examiner (Group)	1440	1500	1560			
Supervisor, Mechanical Tabulation Examining Section (Group)	1800	1920	2040	2160		
Principal Mechanical Tabulator	1980	2100	2220	2340		
Chief Mechanical Tabulator	2400	2520	2640	2760		
Card Punch Operator	1200	1260	1320			
Supervisor, Card Punching Section (Group)	1560	1620	1680			
Special Card Punch Operator	1320	1380	1440			
Supervisor, Special Card Punching Section (Group)	1620	1680	1740	1800		
Mechanical Tabulation Coder	1200	1260	1320			
Special Mechanical Tabulation Coder	1320	1380	1440			
Supervisor, Mechanical Tabulation Coding Section (Group)	1560	1620	1680			
Junior Mechanical Tabulation File Clerk	1140	1200	1260			
Supervisor, Mechanical Tabulation File Section	1560	1620	1680			
Special Mechanical Tabulation File Clerk	1320	1380	1440			
Supervisor, Special Mechanical Tabulation File Section	1560	1620	1680			
Statistical Clerical Work:						
Under Statistical Clerk	1260	1320	1380			
Junior Statistical Clerk	1440	1500	1560			
Senior Statistical Clerk (Group)	1620	1680	1740	1800		
Principal Statistical Clerk (Group)	1980	2100	2220	2340		
Head Statistical Clerk (Group)	2400	2520	2640	2760		
Chief Statistical Clerk (Group)	2820	2940	3060			
Statistical Science:						
Junior Statistician	1800	1920	2040	2160		
Assistant Statistician	2400	2520	2640	2760	2880	3000
Associate Statistician	3240	3360	3480	3600	3720	3840
Statistician (Group)	4140	4320	4500	4680	4850	5040
Senior Statistician (Group)	*	*	*			
Director of the Census	*	*	*			

service, the physical science, the economic and political science services, and the social science service.

In general, the salaries for the lowest classes of statistical clerks and employees engaged in mechanical tabulation are apparently higher than those paid by private enterprises. In the classes immediately above, with salaries ranging roughly from $1,500 to $1,800, the difference between the government service and private enterprises in eastern cities is apparently not very great. In the higher classes of statistical clerks and mechanical tabulators, where long experience, knowledge of the subject, and administrative ability are required, the salaries suggested by the commission are considerably lower than those paid commercially.

The salaries for statisticians are more nearly comparable with those paid university professors than with those paid statisticians in the commercial field. In this connection it should be remembered that the government statistician does not work an academic year and that he is frequently barred from accepting any retainers for special services, and thus cannot add to his income as does a college professor. His writings, moreover, are generally the property of the government and he derives no income from them. In his writings, too, he is restricted by his official position, and although government statisticians and economists frequently are in possession of information which would be of intense popular interest, they not only cannot sell it, but they cannot even make it public. The salaries recommended by the commission, therefore, although representing a material increase over those now being paid, would not put the government statistician on a financial plane of equality with the best paid university professor. The amount of increase, moreover, fails in many cases to offset the increase in the cost of living that has taken place since the positions were filled by the present incumbents, and thus if the salaries are advanced as the commission recommends, the officials will not in fact be as well off as they were when appointed.

The failure to offset the increase in the cost of living is particularly noteworthy in the case of the clerical employees. Prior to the war the popular impression that the government clerks occupying non-administrative positions were generously paid, as compared with those in private enterprises, was undoubtedly correct. The increase in the cost of living has removed this difference, and the recommendations of the commission will not restore it except in the case of the lowest classes of clerical employees. The older government clerks in Washington who were appointed, say prior to 1913, will not find the purchasing power of their salaries fully restored by the recommendations of the commission.

The lowest classes of clerical employees in the government service must necessarily be well paid, as compared with those in private enterprise, as long as Congress maintains the "apportionment" provision of the Civil Service Act. This provision requires that positions in the departmental service at Washington shall be apportioned among the states in accordance with their population. The District of Columbia and the nearby states of Maryland and Virginia have, of course, greatly exceeded their quota, and under normal circumstances a person from one of these states cannot be permanently appointed to an ordinary clerkship. Certain banks and other large corporations have a fixed policy of giving preference to young men, and more especially to young women, who live at home. The government has indirectly adopted a policy exactly the reverse, and almost all its clerical employees must be residing away from their homes. Washington is a city of boarding houses, small apartments, and recently of dormitories. The employee must, therefore, be paid a salary which will permit the maintenance of this individual status. The government cannot take advantage of the well recognized possibility of securing the lower classes of clerical employees at less than the cost of maintaining a person in the individual status by employing girls and boys who are living with their parents.

The rates recommended by the commission can, of course, be defended on the common argument used to support a minimum wage, but in this case no such defense is necessary, for the government could not attract the kind of people that it requires for its clerkships if it did not pay them enough to maintain themselves in Washington.

These matters that have been discussed are among the more important ones that were before the commission with relation to the statistical employees. In its letter of submittal to Congress the following sentence appears: "The task assigned to your commission by the Congress was the largest of its kind ever undertaken, and your commission is not suffering from any illusions as to the degree of perfection attained." It carried its work to the point which permitted it to lay before Congress a comprehensive plan, sufficiently worked out to warrant the passage of the necessary basic legislation to institute a radical and much needed reform in the government's methods of dealing with its employees. Perfection of detail will have to be secured as the organization develops. With all its possible imperfections of minutiae, the report represents the most important step in advance for the United States Civil Service since the Civil Service Act of 1883.

AN INDEX OF INCOMES

By K. G. Karsten, *New York City*

The purpose of this article is to suggest a set of two index figures or coefficients for the measurement and analysis of income and wealth statistics, which shall, without loss of statistical accuracy, be suitable for popular presentation. One of these coefficients gives a quantitative measurement and may be called an index of the size of incomes; the other is qualitative and may be called an index of the distribution of wealth. Both indices involve what may be called a natural law of incomes, with which, since the work of Pareto,* many statisticians are already acquainted, and of which a short explanation is prefixed.

When statistics of income are plotted upon double-logarithmic paper, that is, upon chart-paper ruled logarithmically on both axes, the resulting curve approaches a straight-line. Before plotting, the data must be cumulated downward, as there are no small frequency intervals of equal geometric distance;† and in this article wherever the figures of income are referred to, it is to be understood that the cumulated and not the individual class figures are meant. The cumulated figures (Tables I and II), representing the number of persons report-

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* Vilfredo Pareto, *Cours d'Economie Politique*, Vol. II, pp. 304 *et. seq.*

The present writer unfortunately could not claim acquaintance with the work already done in this field at the time of his investigation and has, therefore, departed slightly from the method of Pareto, without, it must be said, great advantage in such departures. The use of fixation points selected nearer the central portions of the data, has, it is believed, some advantage in the avoidance of possibly artificial deviations at the lower extreme and of chance variations in the small number of quotations at the upper income extreme. The use of fixation points at income levels in the ratio of 10: 1 has the mathematical advantage of the short-cut method noted in the footnote on p. 259.

For graphic presentation, the present writer has finally projected the income levels along the vertical axis, as more readily connoting higher and lower incomes, in spite of the fact that this method projects the unknown variable along the horizontal axis. The so-called "factor of slope" (S), from which the index of distribution is derived, is, like the "inclination" used by Pareto, the tangent of the curve with the horizontal axis, but owing to this reversal of axes, is actually the reciprocal of Pareto's measure, that is, it is the co-tangent of the angle measured by him.

† Income statistics need not be cumulated to give the straight logarithmic curve, but the difficulty of showing the great number of small incomes separately makes cumulation convenient. If the statistics are not cumulated, the individual incomes must be thought of as arranged along a base line, or axis, with the largest incomes at one end and the smallest at the other, the remainder ranging themselves between, in succession. The position along the base line or axis must be on the logarithm of the successive number of the incomes; thus the largest income being at the beginning of the base line, the second largest must be at the logarithm of two, the third largest at the logarithm of three, the fourth largest at the logarithm of four, . . . to the smallest income at the logarithm of its successive number (around 100,000,000 in the United States).

All of this is implied in the cumulated figures used in the text; thus, if we have one person with an income of $10,000,000 and two with an income of $5,000,000 or more, the first being already indicated at $10,000,000, the second person has $5,000,000; if we have three persons with $3,333,333 or more, the first two being known, the third has $3,333,333; if we have four persons with $2,500,000 or more, the fourth one has $2,500,000; if we have five with $2,000,000 or more, the fifth has two millions, etc., etc.

TABLE I

CUMULATED INCOME STATISTICS SHOWING NUMBER OF PERSONS WITH INCOMES GREATER THAN EACH INCOME LEVEL. UNITED STATES, 1914

Income Classes (Incomes Between:)	Number of Persons	Cumulation (Incomes of More Than:)	Number of Persons
$1,000,000 and over	60	$1,000,000	60
500,000 to $1,000,000	114	500,000	174
400,000 to 500,000	69	400,000	243
300,000 to 400,000	147	300,000	390
250,000 to 300,000	130	250,000	520
200,000 to 250,000	233	200,000	753
150,000 to 200,000	406	150,000	1,159
100,000 to 150,000	1,189	100,000	2,348
50,000 to 100,000	5,161	50,000	7,509
40,000 to 50,000	3,185	40,000	10,694
30,000 to 40,000	6,008	30,000	16,702
25,000 to 30,000	5,483	25,000	22,185
20,000 to 25,000	8,672	20,000	30,857
15,000 to 20,000	15,790	15,000	46,647
10,000 to 15,000	34,141	10,000	80,788
5,000 to 10,000	127,448	5,000	208,236
4,000 to 5,000	66,525	4,000	274,763
3,000 to 4,000	82,754	3,000	357,515
Total (all classes)	357,515	Total (over $3,000)	357,515

TABLE II

CUMULATED INCOME STATISTICS. UNITED STATES, 1914–1917, WITH PROFESSOR W. I. KING'S ESTIMATE FOR 1910

Income Exceeded	Number of Persons Having Greater Incomes				
	King's Estimate (1910)	From Tax Reports			
		1914	1915	1916	1917
$10,000,000	5	....	....	....	....
5,000,000	15	....	....	10	4
4,000,000	....	....	....	19	12
3,000,000	....	....	....	33	17
2,000,000	56	....	....	67	41
1,500,000	....	....	....	109	74
1,000,000	154	60	120	206	141
500,000	....	174	329	582	456
400,000	....	243	451	827	635
300,000	....	390	705	1,296	1,015
200,000	415	753	1,307	2,449	2,060
150,000	....	1,159	2,031	3,733	3,362
100,000	3,560	2,348	3,824	6,633	6,664
75,000	....	....	5,880	....	....
50,000	15,190	7,509	10,671	17,085	19,103
40,000	22,190	10,694	14,771	22,696	26,190
30,000	34,190	16,702	21,776	32,764	38,923
20,000	54,190	30,857	37,679	53,775	66,300
15,000	....	46,647	54,154	76,396	96,196
10,000	127,190	80,788	88,256	121,701	161,996
8,000	165,190	....	....	157,309	....
6,000	244,190	....	....	....	....
5,000	....	208,236	208,658	272,252	432,662
4,000	449,190	274,763	267,607	344,279	618,467
3,000	720,190	357,515	336,652	429,401	993,425
2,000	1,437,190	....	....	....	1,832,132
1,500	2,702,190	....	....	....	....
1,000	8,543,190	....	....	....	3,472,890
800	13,542,190	....	....	....	....
600	20,657,190	....	....	....	....
400	25,942,190	....	....	....	....
300	27,655,190	....	....	....	....
200	27,925,190	....	....	....	....
100	27,945,190	....	....	....	....

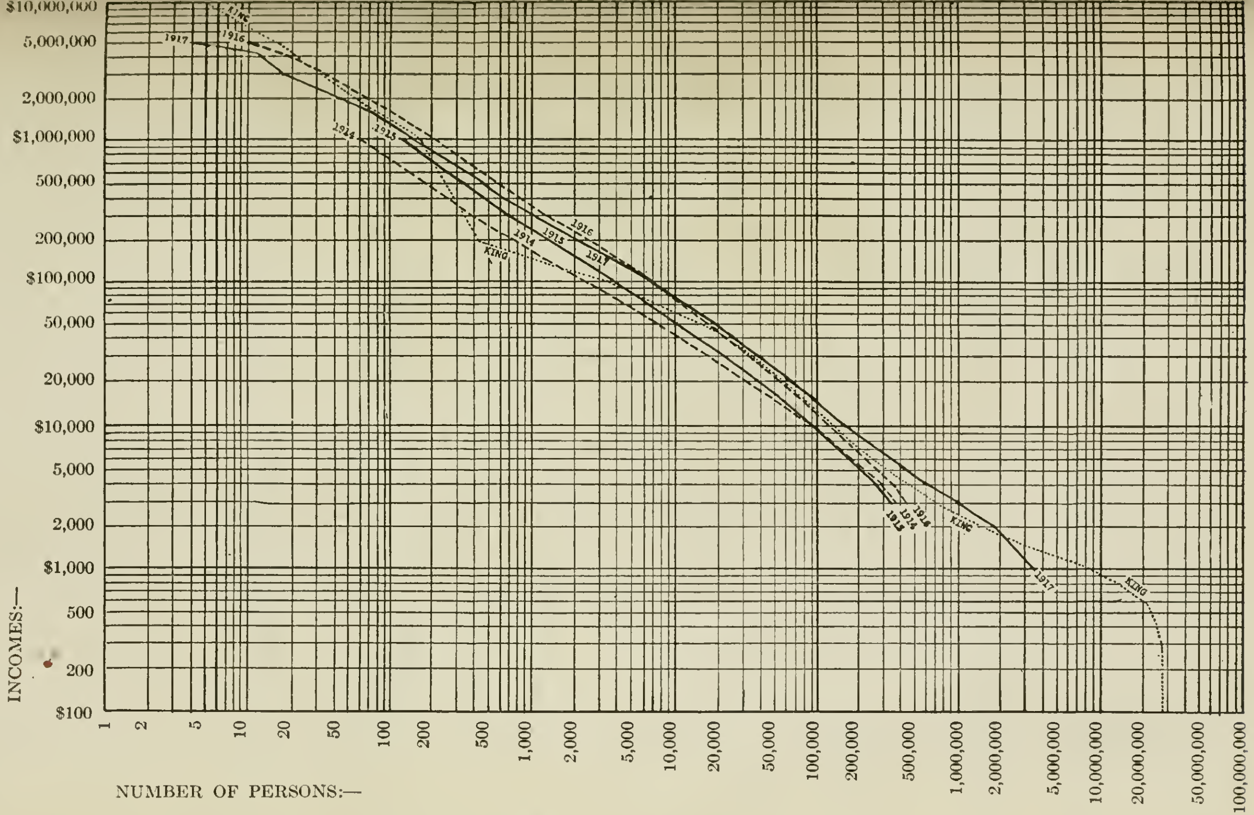

Chart I. Geometric Ogive Curves of Incomes

United States, 1910–17

Showing the ogive curves for the various years and for Professor King's estimate (dotted line), plotted upon logarithmic paper, in which the ordinates represent incomes in dollars and the abscissae represent the number of persons reporting more than such incomes.

ing incomes greater than each income-level, will when plotted (Chart I) form an ogive frequency curve, which may, since both axes are projected logarithmically, be called a geometric ogive curve.

The significance of the curves in the years actually reported (1914–17) lies in their very close approach to a straight line,* and it may, therefore, not be amiss to discuss for a moment their deviation from a straight-line (see Chart II); for it may be that this deviation is not real, but is due to faults in the statistics alone. It is stated in treasury reports that there has been considerable tax evasion, either wilful or negligent. Now it is easily seen that the larger the income, the greater is the temptation (especially under a graduated tax) to conceal portions of income. Were tax collectors humanly corruptible, it might be added that the facilities for concealment would also be greater. The temptation alone may account for a gradual deviation of the curve in the higher income levels. In the very small incomes, on the other hand, there is probably the greatest amount of negligent and unconscious

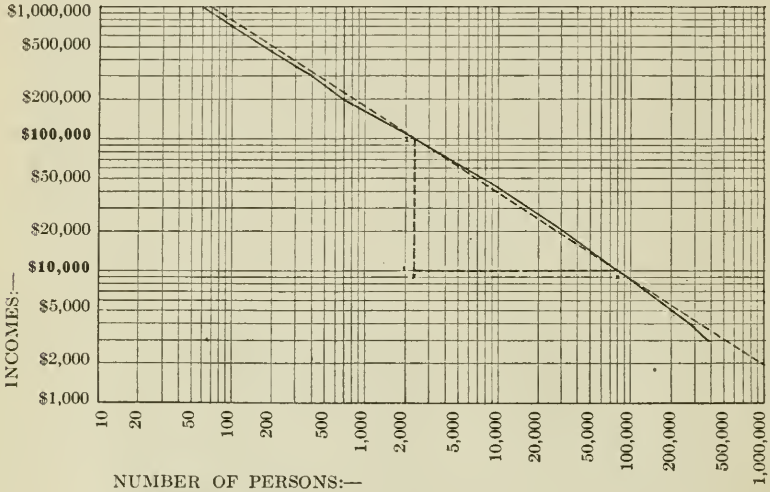

CHART II. NORM PROJECTED THROUGH FIXED POINTS
United States, 1914

Showing the slight deviation of the reported figures (full line), from the norm (dotted line) projected through the fixed points (circles) selected at $100,000 and $10,000. The values from which the index of distribution is computed are shown by the triangle the two legs of which are I/i and n/N.

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* Measured in terms of the tangent of the angle formed by the geometric ogive curve and the ordinates of the paper, the maximum angular deviation of the reported incomes curve from the straight line does not exceed 20 per cent, except at the lower tax limit.

evasion. This includes the farmer who consumes part of the produce of his own farm and makes no report on the produce so used, because no money exchange has taken place to make this a money income.* At the extreme lower tax limit, an abrupt drop in every curve is due to the failure to make any tax report of persons whose incomes are taxable by a small margin only. Operating as these forces do, at different ends, they may be expected to make the curve slightly convex—a form it invariably shows—and the view may be held that the deviations are not true of the phenomena, but are due to the statistical defects.

Obviously, if the true curve be a straight line, it would signify an all-pervasive force or natural law, arranging in strict geometric order or progression the fortunes and possessions of men, and bringing out of the apparent chaos of human society a symmetry and simplicity which is indeed fascinating. This natural law might be phrased as follows: "In any community the number of persons whose incomes exceed any given amount varies inversely and logarithmically with the given amount, modified by a constant factor peculiar to the community." In the constant factor peculiar to the community we should have a coefficient for the community, and although we knew the income distribution through only a small range of incomes, we should be able to unlock the secret of all other incomes in this community.

It is not necessary, however, to adopt the theory that the true curve is a straight line in order to arrive at two useful and significant indices or coefficients for the statistical analysis and comparison of income conditions in various communities. From the simple expedient of a *fitted* straight-line, fitted *at standard and invariable points,* we can derive two such coefficients of ample value in sociological analysis to recommend them in the place of the present lack of relative wealth indices. For although the coefficients will not have definite individual accuracy in themselves alone, yet the variations in these coefficients for different communities, or for the same community at different times, tell a significant story of change in much the same way as relative price figures, derived from a large number of price quotations, tell a story of price changes.

For the sake of simplicity, in this paper two coefficients are suggested and their significance described as though the theory of the straight-line were already an established fact. The attempt is made to insert, from time to time, warnings to the effect that this significance is still theoretical. Even if the curve finally prove to be (when the facts about lower incomes are known) not a straight line, it may be that these will remain useful indices, with the possible addition of a third coefficient of deviation. Meanwhile it must always be remembered that the significance of these coefficients in each community really belongs only to the theoretical straight-line community which the actual communities appear most closely to fit.

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* Some estimates of the value of produce consumed on the farm compiled from investigation among Wisconsin farmers indicate that as much as 20 per cent of the total expense of the farm is for produce so used. (See Secrist, "Statistics in Business," p. 77.) The necessity of including goods with money in considering true incomes was recognized by Pareto.

The selection of the two fixed points upon the actual curve, through which the fitted straight-line is projected (Chart II), is therefore of importance, and it is absolutely necessary that in any given set of coefficients the fixed points be the same for all communities. It is here proposed to set the fixed points where the curve intersects the ordinates of incomes of $10,000 and $100,000. Upon inspection, it will be seen that these parallel closely the general trend of the curve, without venturing too high in the curve where the number of observations (or reports) is small and consequently more subject to chance variations, and without coming into the zone of the more abrupt drop at the bottom of the curve. In certain investigations into the statistics of small parts of the population, it will be necessary to choose fixed points lower on the curve or nearer together, because the number of observations even at $100,000 becomes so small as to be subject to large chance variation; but when this is done the same points in the curve for the entire population should be inspected for their deviation, and the fitted straight-line of the small part of the population should be corrected by this deviation.*

Having fitted a straight line or norm, therefore, at two points, to the curve for any community, the two coefficients for the mathematical expression of this straight line are easily seen. The function of one of these, as already stated, must be quantitative, that is, it must fix the position of the straight line or norm, or of some standard point upon that norm, to the paper, graphically speaking. The function of the other is qualitative; it must define the slope or direction of the norm upon the paper. Let us first consider the latter.

If we define the slope as the tangent of the angle made by the norm and the ordinate or horizontal axis of the paper, we shall see that it may be expressed by the formula:

$$S = \frac{\log I - \log i}{\log n - \log N}$$

when I and i represent the larger and smaller income levels, respectively, at the two fixed points, and N and n represent the number of persons at these levels.* For use as an index or coefficient with popular connotation this factor of slope (S) is, of course, utterly unfitted, involving as it does logarithmic conceptions. Examination will show that the anti-logarithm of S is no more than the ratio between two income levels so chosen that the numbers of persons at these two levels have a ratio of 1:10. Likewise the anti-logarithm of 2 S would be the ratio between two income levels so chosen that the numbers of persons at these two levels have a ratio of 1: 100. In the latter case, if we divided the entire body of persons on the lower income level into groups of 100 persons each, and made the groups as representative† as possible in the matter of high and low incomes, then in each such group there would be one person who is also in the higher income level. Or we might say that if we segregated just 1 per cent of the population in such a way that every one in the 1 per cent group had an income greater than any one in the remainder, that is, if we segre-

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* Some inconclusive study of the nature of the trend of the geometric ogive curve would seem to indicate that its changes in slope proceed in more regular intervals when the angle formed at the base is measured by circular measure. As S is the tangent of the angle, correction in the case described in the text should apparently be made after the angles have been from their tangents reduced into degrees.

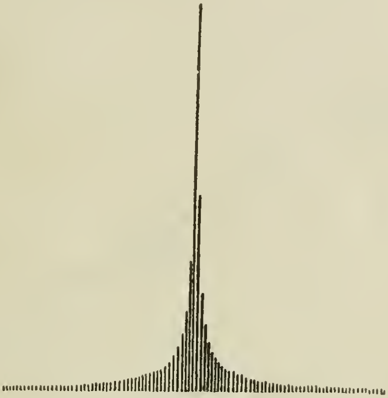

CHART III. 100 REPRESENTATIVE INCOMES

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* A short-cut method can be used if fixed points are always selected at two income levels, one of which is ten times as great as the other. This has been done in the text and in the chart. The result is that the phrase "$\log I - \log i$" or "$\log \frac{I}{i}$" always resolves itself into unity and the formula can be written:

$$S = \frac{1}{\log n - \log N}.$$

† By representative is meant such sampling or selection in the arrangement of the groups, that each group will contain a unit whose ogive curve is identical in slant or slope, with the ogive curve of the entire community. There would then be a considerable uniformity in the matter of the lowest income, but in many groups the highest income would be very great, since at any point along the ogive curve the number of persons plotted includes not only those with the given income, but also those with more than the given income. Hence in these various groups the highest incomes would have many individuals with very large incomes; and the group here called representative is that group (by far the most common) whose wealthiest individual will have only the minimum of the high incomes. The ratio is really between the maximum income exceeded by all of the single wealthiest individuals in the various groups, to the maximum income exceeded by all of the individuals in the same groups.

gated the wealthiest 1 per cent of the population, the anti-logarithm of $2S$ would be the ratio of the minimum income in the wealthiest 1 per cent to the minimum income in the entire population. Here we have a concept which can be grasped by the layman. Roughly speaking, this index of distribution might be defined as "the ratio between the highest and the lowest incomes in a representative group of one hundred persons" (Chart III), or "the ratio of the income exceeded by the wealthiest 1 per cent of the population to the income exceeded by everybody."*

$$\log D = 2S = \frac{2(\log I - \log i)}{\log n - \log N}$$

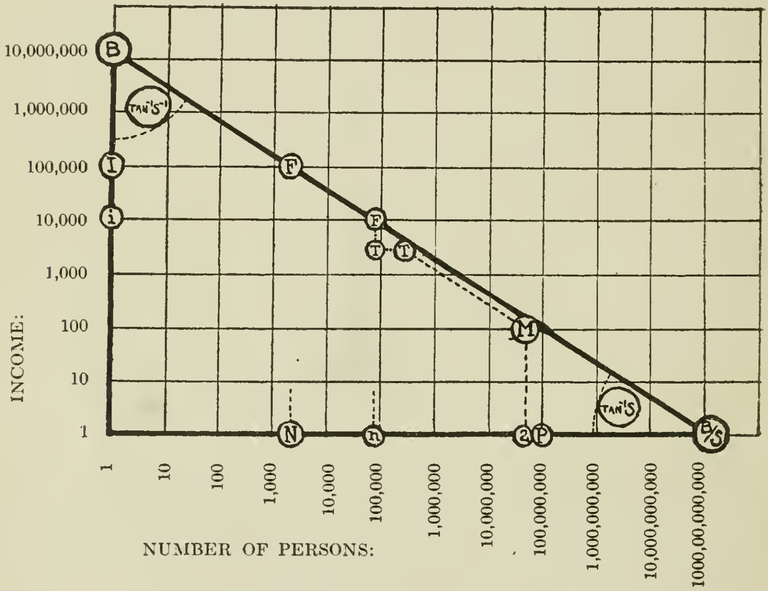

Chart IV. Fully Projected Norm

United States, 1914

Showing the fitted straight line or "norm" projected through the two fixed points (FF) at the intersections of the two known income levels (Ii) with the two numbers of persons (Nn) having more than these incomes. The line is projected to both axes, showing the bases (B and B/S) at its extremities. The computation of the median (M) is shown, one of the fixed points (F) being corrected for the number of persons represented by each tax-payer (TT) and a parallel to the norm being projected to the abscissa of one half (2) of the population (P), the intersection of the parallel line (dotted) and this abscissa (dotted) being at the ordinate of the median income (M).

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* The trouble with this concept is that the minimum income of the entire population, or the income exceeded by everybody, is entirely theoretical, and takes no account of actual dispersion about the lower end of the norm. As a matter of fact, incomes do not cease suddenly at the lower extremity thereof, but before that point is reached, dispersion sets in and becomes quite marked, carrying a large number of incomes into lower levels, probably in the way of a normal probabilities curve.

Before proceeding to the other coefficient, the index of the quantity of wealth, it is interesting to note that from the formula for S we can derive the income level of any given portion of the population, or the part of the population on any given income level. That is to say, knowing S, i, and n in a community, and writing B for the constant $\log i + S \log n$ in that community, we may find the I for any N or the N for any I in that community, as follows:

$$\log I = B - S \log N \qquad \log N = \frac{B - \log I}{S}$$

Here we have the algebraic expression of the natural law of incomes stated above. Either formula may be traced graphically (Chart IV). The important point is that in either formula, while I and N are variables, there is a phrase which we have called B (in the second B/S) which is constant in the community. In the formula it serves as a base for the equation, in the chart it is seen to be the intersection of the norm with either axis.

In this case (B or B/S) we have the quantitative element in the formula, and it would serve if necessary as the quantitative coefficient. But examination will show that it is the logarithm of the number of dollars income of the wealthiest individual (B) or of the number of persons with incomes greater than one dollar (B/S), and that both numbers are fictitious and theoretical.* Hence not only because of its logarithmic conceptions, but also for its wholly fictitious nature, the base of the formula is not suitable as a coefficient for popular presentation. There is nothing to hinder our taking a point somewhere midway along the curve, however. Many such points suggest themselves, such as the intersection of the curve with the ordinate of $3,000. This would give us the number of taxpayers (in early years) as a quantitative coefficient, which we could read as a percentage of the entire population. Or we can adopt a certain abscissa, representing a certain given number of people, or a certain given percentage of the population. It is here proposed to adopt the abscissa of 50 per cent of the population. The constant for each community then will be the ordinate at which the curve intersects this abscissa. In short, it is proposed to use the median income in each community as the quantitative coefficient for that community. Here we have a concept which can be readily grasped by the layman, scarcely any concept would be easier; and yet for statistical purposes it is quite as good as either of the formulary bases, so long as we remember that it is, after all, at present only a coefficient, and does not actually represent dollars and cents of the median income. For at present it is the resultant of a projection of a fitted straight line through two distant points on the curve, which in themselves are only tax reports and subject both to a general upward correction for tax evasion and to a probable error which becomes magnified at the projected point.

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* The following definitions may be easily proved from the chart or the formula:

B is the logarithm of the theoretical income of the wealthiest individual in the community, measured in dollars of income, that is, the logarithm of the theoretical maximum income.

$\frac{B}{S}$ is the logarithm of the hypothetical and purely fictitious number of individuals in the community whose incomes exceed one dollar per year, and this number will greatly exceed the actual population of the community, for the reason that incomes do not exist as small as this amount.

S is the logarithm of the number of dollars income exceeded by one individual in every ten individuals, for every dollar of income exceeded by all of the ten; or in other words, the logarithm of the ratio of the two income levels exceeded by the wealthiest and the poorest individuals, respectively, in every ten persons.

$\frac{1}{S}$ is the logarithm of the number of individuals having more than any income, for every one individual having more than an income ten times as great, or in other words, the logarithm of the ratio of the two numbers of persons having more than any two income levels, one of which is ten times as great as the other.

It is not so easy to compute the median income from the formulary base $\left(B \text{ or } \frac{B}{S}\right)$ as it was to compute the index of distribution (D) from the factor of slope (S). In the first place, the total population of the community must be known. Where the community is the country or a state, it is not difficult, using estimates from the census. But in other cases, as where the community is an occupational rather than a territorial group, it is often impossible, and no median income can be given for such communities.* When we know the entire population, the question next arises as to how large a part of this population do the taxpayers represent. Obviously we cannot count the tax reports as representing only individuals; on the contrary, they are known to represent families. If we know the size of the average taxpayer's family, we can multiply the known number of persons (n) (representing families), on the known income level (i) to correct for the true number of persons (instead of families) on this level. (Though we have heretofore spoken of them as "persons" in this discussion, they are really families.) The resulting "I" will be the median family income. This assumes, however, that tax-paying families are the same in size as non-tax-paying families—a very questionable assumption. By further correcting the known income-level (i)—that is, dividing this income (I) by the number of persons in the taxpayer's family—we can get the income-level exceeded by the average individual in the tax-paying classes. From this it is a simple matter to apply the formula and get the median individual income.*

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* Where no median income can be found for the entire population in any community or group, because the entire population is not known, it is sometimes useful to have at least a median taxpayer's income (family or individual), but such taxpayer's median, or median of incomes over a certain amount, cannot be used or corrected for use in comparison with medians of the whole population.

In all cases, therefore, it is necessary to know the size of the average taxpayer's family before a median can be reached.† Very definitely here we come to the point of estimates alone. Until 1917, no estimate whatever could be made from the income tax statistics. In that year for the first time personal exemption was allowed to taxpayers according to the number of persons in their immediate family who were supported by them. Hence from the total amount of personal exemption allowed, we may know the number of persons represented by the tax reports. The trouble is that this personal exemption was allowed only for heads of families, husband or wife, and dependent children under sixteen. In 1918 the law was altered to include all absolute dependents, so that not until the returns from 1918 are published, with the amount of personal exemption in that year, shall we have something like the true figure as to the size of the average family. In the meantime, however, the estimated medians, though palpably low, will retain for statistical purposes the full index value of the true medians.

When we come to applying this correction for families to earlier years, we will find that the number of wives, who, though living with their husbands, and part of the same family, make out separate reports from their husbands, varies greatly from year to year. And with any increasing odium which may attach to large incomes, the tendency thus to split up the family income formerly reported in its entirety by the husband into parts, reported by both husband and wife, will increase. This process, be it remarked, probably had considerable to do with the decrease in the number of millionaire-income families reported from 1916 to 1917, over which so much publicity was stirred. There is, however, a very constant relation, which can hardly change appreciably from year to year, namely, the number of dependents represented per heads of families. Now the numbers of heads of families in the various years can be computed (Table III), and working from that relation we can proceed to estimates of the size of the average taxpayer's family, and from this to estimates of the median income either for families or individuals, remembering that all such estimates will be subject to uniform revision when the 1918 report is published. Method and comparative values will be the same, but the knowledge of the true size of the taxpayer's family will then merely inject a uniform upward correction.

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* The choice between a median family income and a median individual income depends finally upon whether the natural law of incomes (by this is meant the consistent natural forces operating to arrange human incomes into a giant geometric [or logarithmic] pyramid), applies fundamentally to bread-winners only or to all human beings. The considerations advanced below in the text would seem to place all human beings, whether dependent upon bread-winners or dependent upon employers and customers, alike under the operation of any natural law ordering their incomes.

† Two things militate against the use of a family median income. The first is the fact that we cannot entirely identify computed taxpayers' families (computed as in the text following) with the actual taxpayers' families, because in many families some children have independent or partially independent incomes, which prevents any exemption being allowed the head of the family for them. The second is the fact that we have not definite knowledge of the number or size of natural families in the United States, and particularly in the different states. The census lists (in census years) what it calls "artificial families," for the purpose of which neither blood nor marriage ties but common living and eating quarters are the basis of the family (residents at a boarding-house or hotel being counted as members of a single family), with the obviously questionable result that the urban and densely populated districts are credited with larger families than the rural and thinly populated districts.

Probably the most useful estimate of the size of the average American family can be obtained by dividing the total number of persons represented by the taxpayers, by the total number of tax-paying families. The latter (tax-paying families) is, of course, less than the number of tax-paying individuals, for the reason that many wives, though living with their husbands, make out separate tax reports, and it is still less than the number of adults in the tax-paying classes, for the reason that most wives make out no reports at all. According to this estimate, the natural family in 1917 comprised about 3.21 persons each, itemized as follows: "head of family or individuals living alone," average 1 person; "spouse," average .81 person; "dependent children under 18," average 2.40 persons. This statement must be qualified to the extent of its omission of "other dependents," explained in the text.

The formula for the median incomes remains the same. In the belief that the median individual income is more valuable for statistical purposes than the median family income, the former is proposed as an index of the amount of wealth, the quantitative index of wealth. This belief is grounded in that fact that whether or not independent

TABLE III

COMPUTATION OF TAX-PAYING POPULATION. UNITED STATES, 1914–1917

NOTE: Figures in **bold-face** are taken from tax-reports, other figures are derived. The tax-paying population and the number of persons in this population per tax-payer (T) are subject to revision from later tax-reports not now available.

		(1917) (over $2000)
Joint returns of husbands and wives and separate returns of husbands		**1,450,723**
Separate returns of wives		**20,530**
Separate returns of husbands		20,530
Joint returns of husbands and wives		1,430,193
Wives not making returns, but represented by joint returns		1,430,193
Total adults making returns		**1,832,132**
Total adult population represented by returns		3,262,325
Total personal exemption claimed	**$3,773,079,800**	
Adult personal exemption (@$1,000 each)	3,262,325,000	
Dependent personal exemption	510,754,800	
Total dependent population under 18 represented (@$200 each)		2,553,774
Total population represented by returns		5,816,099
Returns other than from families containing both husband and wife		**360,879**
Population represented by families containing husband and wife		5,455,220
Number of families containing both husband and wife		**1,450,723**
Persons per full family (containing both husband and wife)		3.76

	(1914)	(1915)	(1916)	(1917)
Returns married	**282,806**	**266,153**		
Wives separate returns	**3,985**	**4,819**		
Married couples	278,821	261,334	**355,107**	**1,450,723**
Persons per married couple	3.76	3.76	3.76	3.76
Population repres. by couple	1,048,250	980,000	1,335,000	5,455,220
Other returns	**74,709**	**70,499**	**74,294**	**360,879**
Total population represented	1,122,959	1,050,499	1,409,294	5,816,099
Total returns (over $2000)	**357,515**	**336,652**	**437,036**	**1,832,132**
T—Pop. repr. per tax-p.	3.14	3.12	3.22	3.17

bookkeeping be maintained for each member of the household including dependents, the truth is, strictly speaking, that every human being enjoys the benefits of an income. The view may be taken that dependence itself is really universal whether it be upon heads of families or customers in business. This individual income figure will perhaps correlate better with cost of living statistics, bank deposits, mortality, and other sociological data.

The median individual income can be found from the formula:

$$\log M = \log \frac{i}{T} - S\left(\log \frac{P}{2\,Tn}\right)$$

where P and T represent respectively the entire population and the ratio of the population in the tax-paying classes to the number of tax reports. The median individual income can be used in the formulae for finding unknown incomes by substituting for B, the phrase: $\log M + \log \frac{P}{2}$, remembering that by so doing the reading of N has been changed from families to individuals by the correction for T. In the table (Table IV) the computation of both the coefficients is shown in detail.*

TABLE IV

COMPUTATION OF THE INDICES. UNITED STATES, 1914

NOTE: The total population has been diminished by the tax-exempt population (Indians) to get the net population (P). The number of persons per tax-payer (T) is subject to revision from later tax-reports.

Item	Process	Sign	Anti-logarithm	Log.	Loglog.
Returns over $10,000	Cumulation	n	80,788	4.9073	
Returns over 100,000	Cumulation	N	2,348	3.3707	
Log *n/N*	Subtr. log.			1.5366	.1866
Log *I/i*	Constant				.0000
S	Subtr. loglog	S		.6507	.8134–1
Distribution Index	Double log.	D	20.02	1.3014	
Returns over $10,000		*n*		4.9073	
Persons per tax-payer	Computed	T	3.14	.4971	
2		2		.3010	
2*Tn*	Add. log.			5.7054	
Population total	Census		99,414,340		
Indians (tax-exempt)	Census		335,998		
Population nett	Subtract	P	99,078,342	7.9960	
Log P/2*Tn*	Subtr. log.			2.2906	.3599
S		S			.8134–1
S(Log *P*/2*Tn*)	Add loglog.			1.4903	.1733
T		T		.4971	
Log *T* * *S*(log P/2*Tn*)	Add log.			1.9874	
Income of $10,000	Constant	i		4.0000	
Index of Size	Subtr. log.	M	102.95	2.0126	

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* It is not deemed necessary to point out in the text that in computations of the median, the total population must be corrected to the total population from which taxpayers are drawn. Thus tax exempt groups, such as the American Indians, must be deducted.

It will be seen that the computed median for the whole United States in 1914 was little more than one hundred dollars. Professor King's estimate for 1910 was $800 per family, or about $175 per individual. Surely the median income did not fall so greatly during the interval. The explanation may lie in tax evasion and consequently incomplete reports which are the basis of the 1914 computed median. It may lie partly in the 1910 estimate. It may lie in the theory of the straight line, about which many statisticians are in doubt, and which can only be settled by a complete array of reliable figures in all income classes. It illustrates quite clearly, however, what has been already repeated, that the median computed from present tax reports cannot be taken as an actual measure of dollars and cents. Whatever value it may have at present is limited to use as an index figure in comparing different communities. Nor, with greatly changing efficiency in tax-collection methods, and some changes in tax-computing and tabulating methods, does it greatly interest us to know that the computed median for 1917 is 11 per cent higher than for 1914, for the entire United States. Its present use, even as a coefficient, is probably limited to comparisons of different parts of the country at the same time (Chart VI).

It is probably true that there are a number of real reasons for a lower actual median in the country than is generally supposed. For we must remember that the individual median is not the income which half the families exceed, nor half the bread-winners, nor half the adults; but it is the income which half of the entire population exceeds, and half falls short of. It takes into account, therefore, the actual income of children, babies, the sick, and public charges and dependents of all kinds. Many of these incomes are never thought of as individual incomes, but are covered in the bookkeeping of those upon whom the individuals are dependent. Nevertheless, it is an open question whether the incomes are not still as real in the last analysis as if separate accounts were maintained for each. But we must be prepared to meet with median income figures much lower than wages, possibly lower than cost-of-living standards. How much does the average child in a poor farming district live on, when in New York City, where probably twice as high a percentage of the population pay income taxes as in other parts of the country, the recent survey of the Board of Health shows 20 per cent of the school children suffering from malnutrition.

But whatever real causes there may be for a low median, there are artificial or statistical causes which definitely prevent the computed median (M) from being at present anything more than a statistical coefficient. Let us briefly review these causes. The computed median is the mathematical result of projecting downward to 50 per cent of the population, a straight line which has been fitted to two points arbitrarily selected in the curve of the known income statistics which cover only 5 per cent of the population. Before this computed median can be taken as connoting a real sum of money, three hypotheses must be established: (a) That the curve of income statistics is really a straight line throughout all classes of society; (b) that the two points arbitrarily selected really lie in this straight line; and (c) that the number of dependents per taxpayers has been correctly computed. Until the straight line theory has been accepted in full the first of these hypotheses is in doubt. The second is openly untenable (the most that we can hope for being that the two points lie parallel to the true line) on account of tax evasion. The third admittedly awaits correction from figures compiled under the 1918 tax law and not yet available.*

Every care should, therefore, be taken not to use the present computed median as an actual sum in dollars and cents, but only as a statistical coefficient. For this purpose it is best used in terms of percentages of the average median or of some base reduced to 100 per cent (Chart VI). In such a use the variations in the computed medians, which would result from shifting the arbitrarily selected points through which the straight line is projected, lose importance, since if only the same points are used throughout all communities compared, the relative percentage of each will be about the same, regardless of the location of the points. And even as a coefficient alone, the computed median, or index of the amount of wealth, is subject to so large a probable error, owing to tax evasion, tax collection methods, and tax-computing and tabulating changes, that it certainly cannot yet be used for comparison between different years to much advantage and has only a questionable value in the comparison of different communities for the same year (Chart VI). It has been proposed here in the belief that in the course of time it will be possible to depend more fully upon the median income for quantitative wealth analysis, and that in the meantime there is need for some quantitative as well as a qualitative coefficient in the analysis of the present income statistics.

* The correction in the estimates of the taxpayer's family, which can be expected within another year, on the basis of fuller data as to dependents, will probably not increase the estimates from the present 2.4 persons to more than 3 persons per family. A common habit in American statistics has been to use the census "artificial family" figures of 4.5 persons per family (*cf.* footnote on p. 263). Let us assume, however, that the average American economic or natural family consists of 4.5 persons, in and out of tax-paying classes alike. Let us also assume that the tax collectors have reached only half of the wealth of the taxpayers; in other words, that tax evasion amounted to 100 per cent of the taxes reported. Both of these assumptions are in the nature of maximum possible errors. In the first case, a median income of $200 would be corrected to $175, and in the second case to $400, and in both cases at the same time, to $350.

The significance of this coefficient, in so far as it has any at present, may be illustrated as follows: Where one state shows a larger median than another, we may conclude that the majority of the population is wealthier in the first than in the second state. The median, therefore, indicates the degree of wealth or poverty of the great mass of the people in any community.* And so, according to this index, we can judge the condition of the masses in different states and communities, and in that sense can classify the communities themselves as "rich," average, and "poor" (Chart VI). It need not be added that to turn a coefficient of money wealth into a coefficient of real purchasing-power, the price-changes must also be considered.

It remains to make clear the significance of the other coefficient, the index of the distribution of wealth, which has been already computed. It is for sociological purposes far the more important of the two and, apart from the doubt attaching to the straight-line theory, and some smaller probable error due to tax evasion, is free of the weaknesses of the quantitative coefficient (the computed median). It has been roughly defined as the ratio of the highest and lowest incomes in each average or representative sample group of one hundred persons (or families) in the community. It denotes the geometric progression in which incomes increase in size as they decrease in number. Thus where the index of distribution is 60, there will be one individual with more than $60,000 a year for every hundred with more than $1,000; there will be one individual with more than $600,000 for every hundred with more than $10,000; and so on throughout the community's range of incomes. An increase in the index will mean a higher income for the one individual; a lower index, a lower income for him. So a disproportionate rise in the fortunes of the few or a disproportionate fall in the fortunes of the many, will be reflected in a higher index of distribution; and vice versa, a disproportionate fall in the fortunes of the few or rise in the fortunes of the many will be reflected in a lower index of distribution.

It is not the actual wealth of the people measured in dollars and cents, nor even in terms of price changes, which determines their buying power in the long run so much as the relation of their wealth to the wealth of others in the same community. Prices themselves appear to be affected, not alone by the general wealth but also by this comparative or relative distribution. The trend of modern economics is placing ever greater importance upon this comparative consuming power of the different members of the community, and attributing to it an influence upon the general level of prices and indeed upon the entire trend of productivity in the community. Into the effects of the injection of many relatively large incomes into a community, upon prices in that community, and upon the shifting of production objectives from the so-called necessities to the so-called luxuries, it is not the province of this discussion to go; but it must be seen that it is precisely the extent of such injection of relatively large incomes of which the index of distribution is a measure.

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* Were it possible to obtain the average per capita income, the latter might be advanced in place of the median as a coefficient of wealth. Habit has already gone far to establish the per capita wealth (not merely income) as such a coefficient. But it is submitted that while the simplicity of the computation of the mathematical (or arithmetical) average has much to recommend it, the latter figure has not an iota of the significance which attaches to the median in this connection. Commonly the median has not been obtainable, because the distribution of incomes was lacking. When it can even be estimated, it is believed that its wealth of human significance places it easily above the arithmetical average in usefulness.

It may even be argued that the index of distribution is the measure of the good or bad health, economically speaking, of income and wealth conditions in a community; that its variations reveal more truly than other indices the actual changes of distribution in all that relates to incomes and earning power, and to a considerable degree serve to mark the even less tangible forces of human happiness, citizenship, and both producing and consuming powers of the individual. We tread here upon ground so delicate that any heavy pressure of the point will break through completely, and the utmost that can be defended in such a general interpretation is that the index of distribution, *ceteris equibus*, records a very vital and sensitive factor in the shifting conditions of human life.

To be specific, let us assume two extreme conditions of society, the one where wealth is equally enjoyed by all, and the other where one individual owns and enjoys all the wealth of the community. Such conditions are purely hypothetical, but for lack of a better phraseology the one may be described as communistic and the other as economically monocratic. In these communities, the index of distribution would be, in the first case, unity, in the second infinity. Between these two extremes we may take as a mid-way community one in which the number and sizes of incomes exceeded would vary inversely,* and the index of distribution would be 100.

What is the significance of this mid-way community? Perhaps it can be illustrated briefly by assuming that we wish to sell in this community an article which every one who can will purchase, but will purchase only once. In the mid-way community, it makes no difference what price we set, our gross sales will amount to the same sum.

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* In such a community the second richest person would have an income of one-half the income of the richest person, the third richest person would have one-third, the fourth would have one-fourth, and so on down to the one-hundred-millionth person, who would have but one one-hundredth-millionth of the income of the richest individual.

For in this community, for each and every person having a hundred dollars to spend, there are five persons having $20 each, ten persons with $10 each, and one hundred who have one dollar to spend. Whether our price be one dollar or a million dollars, we shall have the same gross receipts from sales. But as the index falls below 100, our potential market is greater if a lower price be set; when the index is greater than 100, our potential market is larger if the price is raised. Of course, in actual cases many other factors would enter into buying motives and price fixing. The case is here put only to illustrate a balance in the mid-way community.

Adopting this mid-way community whose index is 100, therefore, as a turning point between two conditions in which the wealth of the many poorer or the few richer predominates, we find ourselves at a loss for words with which to describe the significance of the two conditions. It may be observed that in a more democratic distribution of wealth the index will be lower, while in a more plutocratic distribution the index will be higher, and that to either trend the response of the index is immediate. Exception may be taken to the use of the over-worked words "democratic" and "plutocratic" in this connection, but the present writer can find no others which carry the connotation. Without wishing to abuse the meaning of these words, they are offered as the best translation of the two vitally significant conditions described. Where the index is less than one hundred, the community would then be described as economically more "democratic" than "plutocratic"; where the index is more than one hundred, the community would be called economically more "plutocratic" than "democratic"; and in comparing different communities by the index of distribution of wealth, we could classify them—always remembering the inadequacy of the words—as economically "democratic," average, or "plutocratic."*

The trend of the United States in the last four years in which statistics are available, as shown by this index of the distribution of wealth, is extremely interesting (Table V). It will be seen that throughout the early period of the European war the rise of the fortunes of the few was rapid and the conditions of wealth distribution were leaving a point of great economic "democracy" and rapidly approaching a point of economic "plutocracy." We see that in 1917, upon the entrance of this country into the war, this course was halted and a slight return toward "democracy" set in. The cause of this reversal of trend may perhaps be found in the governmental interference and price-fixing which accompanied the conduct of the war. If so, the measure of government control experienced by this country was extremely beneficial to the great majority of the population for at least the time being. The movement of the index of wealth distribution in later years as figures become available from the tax collector's office, will be of great interest in showing how permanent or temporary was this trend away from "economic plutocracy."

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* For certain statistical purposes the weakness of any arithmetical relative index applies to the index of distribution, in that changes of similar character are more exaggerated in amount in the large indices than in the small ones, precisely as happens in relative price indices which are measured arithmetically. If the logarithm of the indices (of distribution) be used, the changes will be marked more evenly. Or if the index of distribution is plotted on logarithmic paper the same result is reached. Either step is virtually the adoption of the factor of slope (S) from which the index of distribution (D) was computed.

TABLE V

INDEX OF DISTRIBUTION OF WEALTH. UNITED STATES, 1914-1917

Year	Index (D)
1914	20.02
1915	29.31
1916	38.26
1917	27.75

An interesting comparison can also be made with the countries included in Pareto's survey. In the table (Table VI) the conditions noted by him are set forth, after translation into the index here

TABLE VI

DISTRIBUTION OF WEALTH ABROAD. (PARETO, "COURS D'ECONOMIE POLITIQUE")

Country	Province	City	Urban or Rural	Year	Index of Distribution (D)
France	....	Paris (rents)	Urban		18.8
England	....	....	Total	1843	21.5
				1880	30.3
Germany	....	Augsburg	Urban	1471	25.0
				1498	22.9
				1512	38.8
				1526	59.4
	Saxony	....	Total	1880	18.4
				1886	21.1
	Prussia	....	Total	1852	11.4
				1876	14.6
				1881	14.3
				1886	15.5
				1890	17.8
				1894	17.8
Italy	Anconia, Arrezzo, Parma and Pisa		Urban		32.7
	Florence		Urban		26.2
	Perugia	....	Urban		15.3
			Rural		28.8
	....	Misc. cities	Urban		24.0
Switzerland	Basle		?	1887	41.0
Peru	....	....	Total	ca. 1800	13.1

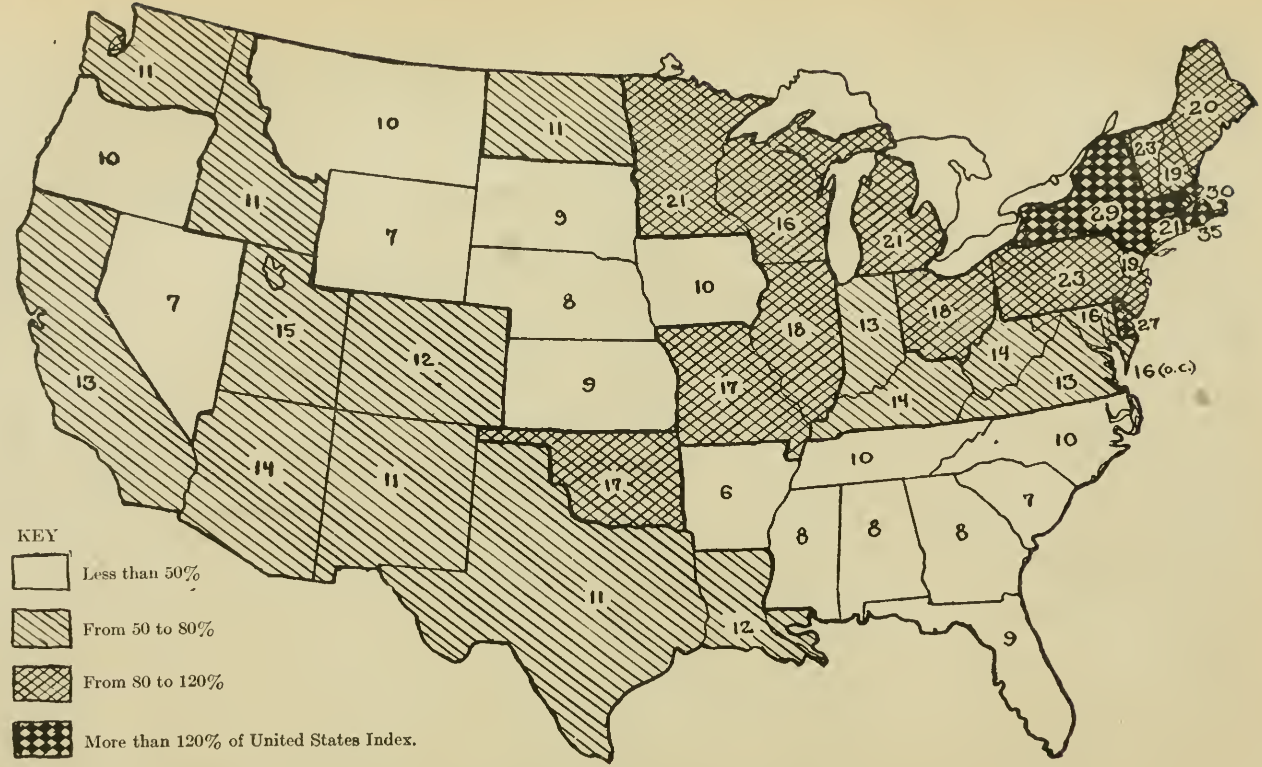

Chart V. Distribution of Wealth
United States, 1914
(United States Index—20)

adopted.* The history of the city of Augsburg in the fifteenth and sixteenth centuries is extremely significant of social conditions in a decadent community drifting from democracy to plutocracy. The same trend, less marked, is evident in the Prussian figures.

Another interesting use of the index may be made from the detailed statistics of income prepared by the government in 1916 (Table VII) in which occupational analysis was made. It will surprise few to find the professions so very much more "democratic," economically speaking, than the business or capitalistic occupations.

TABLE VII

DISTRIBUTION OF WEALTH BY OCCUPATIONS. UNITED STATES, 1916

Occupations	Index	Occupations	Index
Total (All groups)	38.3	Business Group (*continued*)	
Professional Group	15.0	Production	61.3
Professions proper	14.1	Agriculture	18.8
Military	7.6	Lumber-owners	30.1
Public service—civil	11.5	Mine-owners and operators	217.5
Law	22.9	Manufacturers	93.6
Clergy	9.2	Distribution	29.6
Medical	7.7	Merchants and dealers	34.3
Teaching	8.3	Travelling salesmen	6.9
Fine arts	18.5	Catering	14.8
Writing	17.7	Hotel owners, etc.	13.1
Stage and music	31.4	Saloon keepers	8.5
Art and sculpture	13.2	Sportsmen, turfmen, etc.	9.3
Architects	15.3	Theater owners	39.0
Technical	14.7	Other business	35.2
Engineering	16.9	Business not stated	56.2
Accounting	10.1	Financial Group	83.2
Other professions	20.6	Bankers	89.1
Profession not stated	17.6	Insurance brokers	22.6
Business Group	31.2	Insurance agents, etc.	11.8
General	18.9	Real estate brokers	19.3
Corporation officials	29.6	Stock & bond brokers	595.0
Other office employees	18.3	Other brokers	76.3
Laborers	12.3	Investors and speculators	95.6

A geographical analysis of the distribution of wealth cannot be so accurately made from the reports, for reasons connected with the method of reporting,† but in spite of its greater margin of error, such

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* Pareto's measure was the tangent of the angle formed by the fitted straight line to the axis on which the incomes were plotted. As explained in the footnote on p. 253, this is the reciprocal of the factor of slope (*S*) here used. So that the index of distribution quoted in the table is simply the anti-logarithm of twice the reciprocal of his measures.

† "Income reported by an individual or corporation in one state may have been derived from sources in other states." (Statistics of Income, 1916, p. 12.) Hence the figures show geographical distribution of receipt of incomes, but not of source of incomes. A subsequent statement, that "for the collection of tax at the source the collecting agent filed the return in the state in which the agent was located, regardless of the residence of the person earning this income," applies only to corporate returns, not to personal returns, since payments of tax at source are credited to individuals wherever they reside.

The year 1916 is exceptional in income statistics, and not really to be compared with other years, for the reason of a change in reporting adopted in that year only. This change, introducing a statistical difficulty which can hardly be overcome, is as follows: If A and B, married—husband and wife—filed separate reports, A for $10,000 and B for $5,000, they were entered in the final report in 1914, 1915, and 1917 as two returns of $10,000 and $5,000 each, but in 1916 they were entered as one return of $15,000, and in the occupational analysis of 1916 they were entered as two returns of $15,000 each.

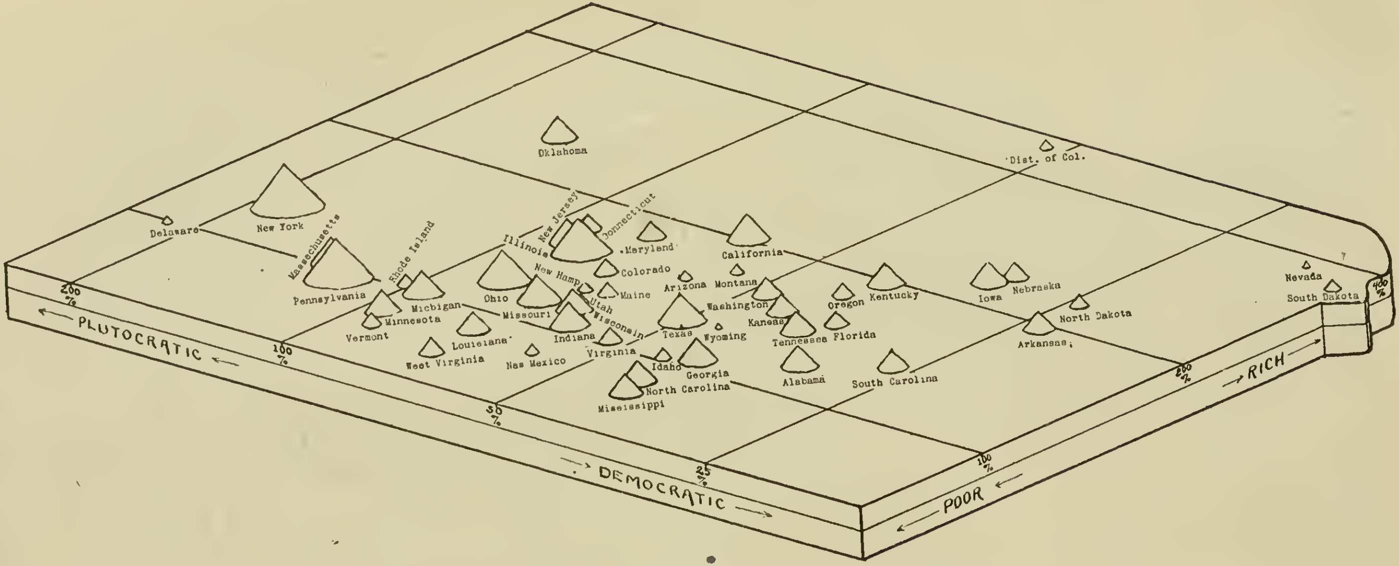

Chart VI. Wealth Conditions in Various States

United States, 1916

Showing each state as a cone, of which the area of the base represents the population of the state, and the position upon the two axes, the two indices of wealth (index of size and index of distribution) of the state as compared to the two indices for the entire United States (U. S. = 100% on both axes). It should be observed that the indices for Nevada and South Dakota are based upon such scant returns as to make them quite unreliable, and their extreme position has little significance. The difference between urban populations and total urban and rural populations is perhaps illustrated by the position of the District of Columbia.

an analysis is of great interest (Chart V). Note for example that the entire south, where the median income is low, and the wheat belt, where it is high, both show a very "democratic" structure. Delaware, Rhode Island, Massachusetts, and New York are extremely "plutocratic." Iowa, a farming state of very high median income, where the number of automobiles per capita is largest, has a low index of distribution, while Oklahoma, also an agricultural state, but rich in mineral resources, has a high index.

Instances of the use of this index could be multiplied greatly, as also of the use of the quantitative index, but it is believed that the foregoing sufficiently illustrate the method. In conclusion, we may say that the two indices or coefficients here suggested for the measurement of income conditions, rest upon the following steps:

(a) Statistics of income are cumulated downward to show the number of persons having more than each amount of income.

(b) The cumulated statistics are plotted upon double-logarithmic paper and a straight line is fitted to their curve at two points arbitrarily selected.

(c) The two points are selected arbitrarily at the intersection of the curve and the ordinates of the incomes of ten thousand and one hundred thousand dollars.

(d) At the intersection of the projected straight line and the abscissa of half of the population, after the necessary corrections for the size of tax-paying families, the indicated median individual income is read from the ordinate at this intersection and is taken as an index or coefficient of the size of incomes in the community.

(e) The tangent of the angle made by the fitted straight line and the base or horizontal axis of the paper, upon which the number of persons has been projected, is taken as one-half of the logarithm of the index or coefficient of the distribution of wealth.

By the use of these two indices we can expect to classify communities as relatively "rich" or "poor" and (economically or financially) "democratic" or "plutocratic" (always understanding these expressions in the limited sense above detailed). We can look for communities of four classes, namely: "rich and democratic," "rich and plutocratic," "poor and democratic," and "poor and plutocratic"; in short we may have every combination of the two conditions in every degree (Chart VI).* And the great interest will not lie so much in the determination of these conditions at any given point of time, as in the discovery of the nature of the changes in these conditions in the community or communities, from time to time. For society is rarely static; it is normally dynamic, and the chief problem of interest is where, when, and how it is moving.

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* A useful study would consist of the collection of the two indices for a large number of groups of the population with the idea of finding any degree of correlation which may exist between the two. *Prima facie* there would appear to be none, and it is, of course, true that any statistical correlation based upon medians which are not fairly reliable may be attributed to statistical errors (for the index of distribution enters into the projection downward to the median, and is, therefore, a component part of the

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median). But some preliminary examination seems to indicate a rather large degree of correlation, whereby the larger the index of distribution the smaller the median income. This will be seen in the chart (Chart VI) where most of the states are grouped in a broad zone running diagonally across the board. If such a correlation can be established, the significance is very great, as it will mean a sweeping revision of our present basis of judging prosperity. That is to say, if it can be proved that, using the terminology of the text, "plutocratic" communities are normally "poor" and "democratic" communities are normally "rich," it means that as the volume of visible wealth owned by the very rich members of the community grows larger and larger, the condition of the great mass of people in that community is not improving, but is deteriorating, and great wealth will in itself become one of the signs of such deterioration.

A GRAPHIC METHOD FOR PRESENTING COMPARATIVE COST ANALYSES

By H. R. Bonner, *United States Bureau of Education*

Considerable demand has arisen for a method of unit cost analysis which will show graphically just how much money is being spent for various purposes and whether such expenditures are proportionately high or low. The following article presents such a method for analyzing and interpreting the expenditures incurred by nine state normal schools. The applicability of the plan outlined is not limited, however, to the educational field alone, but is equally adaptable to other activities where the expenditures of several plants or systems of any type are to be compared.

LIMITING THE STUDY

These nine state normal schools have been chosen for study from a list of 58 such schools submitting similar reports to the Bureau of Education for 1917–18, because they vary considerably in size and possess wide deviation from the general practice in the distribution of their costs among the generally recognized functions of expense. Only nine schools have been chosen, since they serve to illustrate this graphic method of presentation and the principles involved therein, and since it is not the purpose of this article to furnish a complete analysis of such statistics of all normal schools. The content of the subject has been sacrificed, therefore, for the sake of simplicity in presentation.

TABLE I—TOTAL CURRENT EXPENSES IN NINE STATE NORMAL SCHOOLS, 1917–18

Code number of school	Attendance weeks	Total current expenses	Cost of administration	Cost of instruction	Cost of operation of plant	Cost of maintenance	Miscellaneous costs
1	2	3	4	5	6	7	8
9	1,558	$28,437	$2,640	$16,360	$3,606	$2,102	$3,729
7	8,766	90,325	8,692	54,906	19,059	812	6,856
5	15,243	122,777	9,000	30,113	16,455	61,656	5,553
4	15,909	110,741	5,113	31,882	29,743	40,201	3,802
6	9,618	59,541	7,286	34,364	16,499	492	900
2	28,344	165,645	6,794	38,998	71,495	44,237	4,121
1	39,116	191,780	13,642	142,683	20,030	8,425	7,000
3	17,577	68,966	5,700	48,790	11,704	1,622	1,150
8	6,805	15,444	2,330	9,298	3,816	....	......
Totals	142,936	$853,656	$61,197	$407,394	$192,407	$159,547	$33,111
Average cost (per student per week)	....	$5.97	$0.43	$2.85	$1.35	$1.11	$0.23
Per cent of total	....	....	7.2	47.7	22.6	18.6	3.9

SIGNIFICANCE OF THE CODE NUMBER

Each school in Table I has been assigned a significant number which indicates the relative size of the institution as measured in attendance weeks. Thus, school No. 1 is the largest, having a total of 39,116 student or attendance weeks, and school No. 9 the smallest, with only 1,558 similar units. In ascertaining the number of attendance weeks, the attendance of one student for one week at the school is considered a unit. If a student attends for 36 weeks or one year, the institution is accredited with 36 student weeks or attendance weeks. If a student withdraws from school after attending for six weeks, the school is given credit for only six attendance weeks. Students in extension and correspondence courses have been omitted from consideration. Thus, each school is measured by the same unit, thereby permitting a just and fair comparison of expenditures.

ACCOUNTING TERMINOLOGY

In order that a comparison of expenditures may be justly made, it is necessary to eliminate from the field of study all unusual expenditures. Consequently, all capital outlays for new buildings, grounds, and new equipment have been excluded, and only those expenditures have been included which are likely to be constant from year to year and which are usually termed *current expenses.* It would be unfair to include *capital outlays* since possibly only one school in the nine would have spent any considerable sum for the construction of a new building during the year. Such unusual expenditures, which are designed to serve for a period of years to come, must be eliminated from consideration in such a study of annual expenditures. Consequently only *current expenses* are analyzed. This major classification includes the costs of *administration*, of *instruction*, of *operation of plant*, of *maintenance*, and of *miscellaneous* items. The cost of *administration* usually includes the salaries and expenses of the president or principal and of the controlling or governing board. The cost of *instruction* includes the salaries of deans and teachers, the cost of text-books and any amount spent for supplies (materials which when used are of no further value) used in instruction or in the actual teaching process. Under *operation of plant* are placed the wages of janitors, firemen, and engineers; the cost of fuel, water, light, and power; and the supplies used in keeping the school plant fit for occupancy. *Maintenance* costs include expenditures for repair work and for the replacement of outworn furniture, apparatus, etc. *Miscellaneous* costs constitute a catch-all group which includes the cost of medical inspection, transportation of pupils, school libraries, lunches, lecture courses, rent, insurance, contributions, and a host of other auxiliary agencies. Great variation from the general practice, therefore, may be expected among the schools on this score. In Table I the total current expenses were classified and distributed by each school under these five subdivisions.

THE AVERAGE AND THE MIDDLE HALF

In this method of cost analysis, the arithmetical average is used as a basis with which to compare the total current expenses and also the various subdivisions of this total. It is found to possess a certain mathematical property not characteristic of the median, as will be shown below.* Even with so small a number of schools as nine, the median and the average are not materially different. Although the median is not used, its near relatives the first and third quartiles have been utilized to mark the boundaries beyond which it is questionable for an institution to transgress. A sort of hybrid has, therefore, been introduced—the middle half or "safety zone" and the average. These "safety" and "danger" zones have been indicated clearly in the accompanying figures on three different counts.

It has become almost an established practice, especially in the analysis of school costs, to divide the school systems studied into four equal or nearly equal groups, according to the magnitude of the unit cost. Schools having expenditures falling within the upper or lower fourths are usually considered as having high or low costs. The schools falling within the middle half of the array are within the so-called "safety zone." The extreme costs may be more or less justifiable if all the conditions were known, but ordinarily such justification does not exist. It might be contended that all high unit costs are commendable in view of the fact that such a meagre amount is often spent on education. It should also be borne in mind that small schools usually have comparatively high unit costs. A reduction in cost might mean the discontinuation of the institution.

THE AVERAGE COSTS

In Table I the average costs for the nine normal schools combined have been secured by dividing the respective total costs by the total number of attendance weeks. It is found that the average cost per attendance week for all purposes is $5.97. This average implies that it costs $5.97 to maintain a normal school for a week for each student in attendance. Of this amount, 43 cents goes for administration, $2.85 for instruction, $1.35 for the operation of plant, $1.11 for maintenance costs; and 23 cents for miscellaneous purposes. Thus, 7.2

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* See Bulletin No. 81, 1919, Bureau of Education, by Blauch and Bonner.

per cent of the total cost in the "average" school goes for general control, 47.7 per cent for instruction, 22.6 per cent for operation, 18.6 per cent for maintenance, and 3.9 per cent for other purposes. These averages and percentages form the bases with which the practice of individual institutions is compared. Each school contributes its weight to the "make up" of these basal figures.

THE INDIVIDUAL COSTS

The average cost per attendance week has been computed for each institution and the results placed in Table II, in columns 2, 4, 9, 14, 19, and 24. The corresponding averages for all schools combined have been carried forward from the preceding table and placed in the proper columns in the same table. In school No. 9, the total cost per attendance week is $18.25. Of this amount, $1.69 is spent for administration, $10.50 for instruction, $2.31 for operation, $1.35 for maintenance, and $2.40 for miscellaneous purposes. These amounts are respectively 9.3, 57.6, 12.6, 7.4, and 13.1 per cents of the total, $18.25. These proportional percentages are shown respectively in columns 8, 13, 18, 23, and 28 of the table.

THE TOTAL COST CURVE

The costs in each institution and in all schools combined have been reduced to a uniform basis, *viz.*, the cost per student week. The relationship of this weekly cost in each school is now compared with the average cost in all schools. The order in which the schools appear in both the tables and the graphs is determined by the magnitude of this cost per attendance week as shown in Table II, column 2, and by the continuous heavy curve in the diagrams. In school No. 9, the cost is $18.25 or 3.06 times the average cost of $5.97. In other words, the cost per student week in school No. 9 is over three times the average cost. This ratio is placed in Table II, column 3, and is used in locating the first point on the heavy curve in the charts. As this ratio indicates the deviation from the general practice geometrically, instead of arithmetically, it is best termed the *ratio of geometrical deviation.*

In two ways at least this ratio is superior to the arithmetical deviation so frequently found. For instance, the arithmetical deviation of the total cost in school No. 9 from the average cost is +$12.28. The corresponding deviation of school No. 8 from this average is −$3.70. The significance of these differences is not easily grasped. The first denotes that school No. 9 is higher than the average by $12.28, and that school No. 8 is lower than the average by $3.70. But neither shows what proportional reduction or increase is necessary to effect a com-

TABLE 11—AN ANALYSIS OF THE CURRENT EXPENSES PER STUDENT WEEK IN NINE STATE NORMAL SCHOOLS, 1917-18

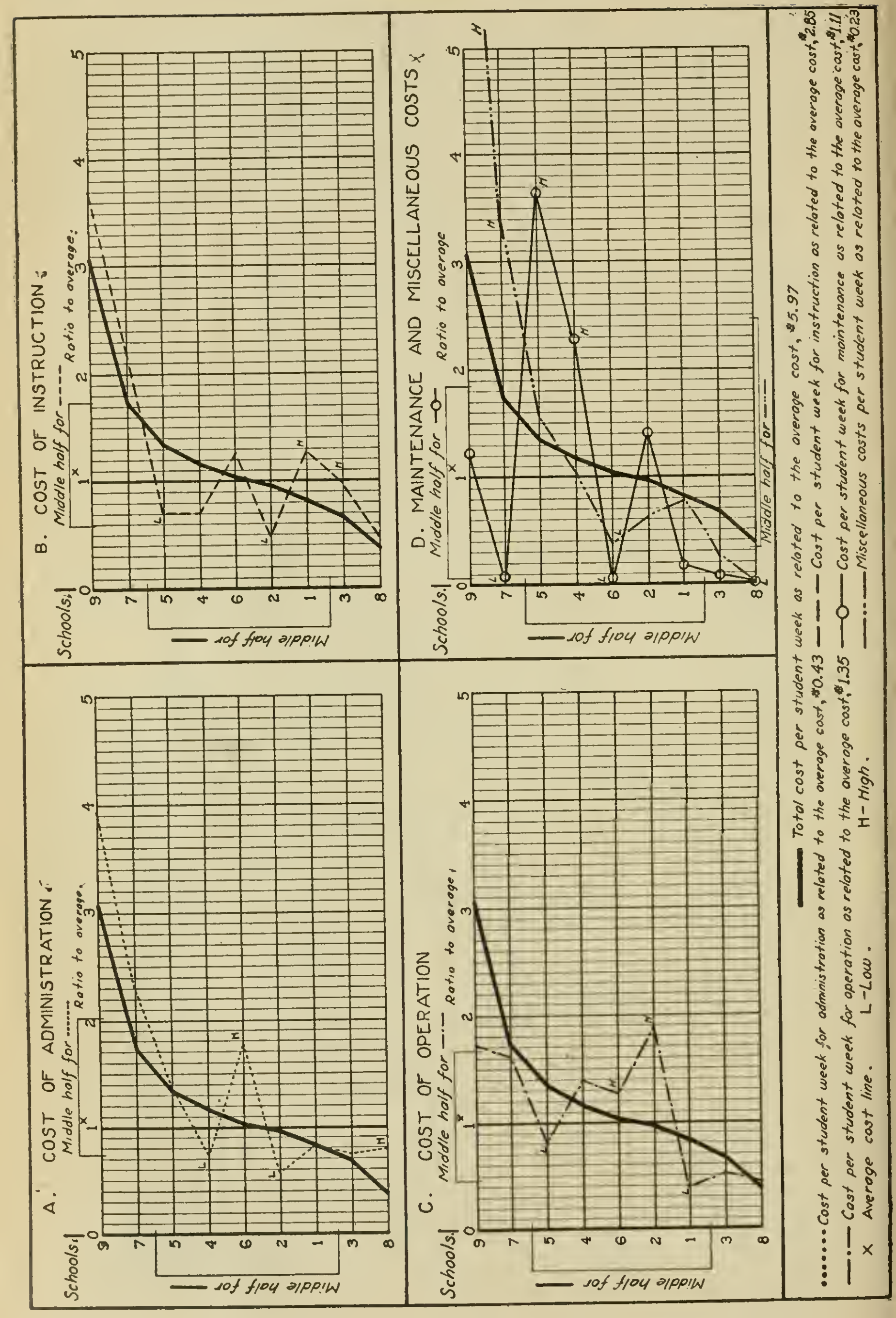
Code number of school	Total current expenses per "student week"		Cost of administration per "student week"					Cost of instruction per "student week"					Cost of operation of plant per "student week"					Cost of maintenance per "student week"					Miscellaneous cost per "student week"				
	Amount	Ratio to average*	Amount	Ratio to average*	Geometrical deviation from total cost ratio†		Per cent of total	Amount	Ratio to average*	Geometrical deviation from total cost ratio†		Per cent of total	Amount	Ratio to average*	Geometrical deviation from total cost ratio.†		Per cent of total	Amount	Ratio to average*	Geometrical deviation from total cost ratio†		Per cent of total	Amount	Ratio to average*	Geometrical deviation from total cost ratio†		Per cent of total
					Negative	Positive				Negative	Positive				Negative	Positive				Negative	Positive				Negative	Positive	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
9	$18.25	3.06	$1.69	3.93	.....	1.28	9.3	$10.50	3.69	.....	1.21	57.6	$2.31	1.71	.66	.....	12.6	$1.35	1.22	.40	.....	7.4	$2.40	10.44	.....	3.41	13.1
7	10.30	1.73	.99	2.30	.....	1.33	9.6	6.26	2.20	.....	1.27	60.8	2.18	1.61	.93	.....	21.1	.09	.08	.05	.....	.9	.78	3.39	.....	1.96	7.6
5	8.05	1.35	.59	1.37	.....	1.02	7.3	1.98	.70	.52	.....	24.6	1.08	.80	.59	.....	13.4	4.04	3.64	.....	2.70	50.2	.36	1.56	.....	1.16	4.5
4	6.96	1.17	.32	.74	.63	.....	4.6	2.00	.70	.60	.....	28.7	1.87	1.39	.....	1.19	26.9	2.53	2.28	.....	1.95	36.3	.24	1.04	.89	.....	3.5
6	6.19	1.04	.76	1.77	.....	1.70	12.3	3.57	1.25	.....	1.20	57.7	1.72	1.27	.....	1.22	27.8	.05	.05	.05	.....	.8	.09	.39	.37	.....	1.4
2	5.84	.98	.24	.56	.57	.....	4.1	1.38	.49	.50	.....	23.6	2.52	1.87	.....	1.91	43.2	1.56	1.40	.....	1.43	26.7	.14	.61	.62	.....	2.4
1	4.90	.82	.35	.81	.99	.....	7.1	3.65	1.28	.....	1.56	74.5	.51	.38	.46	.....	10.4	.21	.19	.23	.....	4.3	.18	.78	.95	.....	3.7
3	3.92	.67	.32	.74	.....	1.10	8.1	2.78	.98	.....	1.46	71.0	.67	.50	.75	.....	17.1	.09	.08	.12	.....	2.3	.06	.26	.39	.....	1.5
8	2.27	.38	.34	.79	.....	2.08	15.0	1.37	.48	.....	1.21	60.4	.56	.42	.....	1.11	24.6	.....	.00	.00	.....	.0	......	.00	.00	.....	.0
All schools	$5.97	1.00	$0.43	1.00	‡.81	§1.51	7.2	$2.85	1.00	‡.56	§1.36	47.7	$1.35	1.00	‡.62	§1.20	22.6	$1.11	1.00	‡.05	§1.69	18.6	$0.23	1.00	‡.38	§1.56	3.9
Legend	●	——		----					---					—.—					—o—					----			

* Divide cost per student week by the average cost for all schools.

† Divide the ratios to the average cost for any function of expense by the corresponding ratio for the total cost in column 3, *i. e.*, column 5 divided by column 3; column 10 divided by column 3; etc.

‡ First quartile—point midway between the second and the third lowest deviations.

§ Third quartile—point midway between the third and the second highest deviations.


A. COST OF ADMINISTRATION
Middle half for ...... Ratio to average
B. COST OF INSTRUCTION
Middle half for - - - - Ratio to average
C. COST OF OPERATION
Middle half for —·— Ratio to average
D. MAINTENANCE AND MISCELLANEOUS COSTS
Middle half for —○— Ratio to average
Middle half for —··—
Schools
0
1
2
3
4
5
9
7
5
4
6
2
1
3
8
Middle half for ——
x
L
H
—— Total cost per student week as related to the average cost, $5.97
······ Cost per student week for administration as related to the average cost, $0.43
— — — Cost per student week for instruction as related to the average cost, $2.85
—·— Cost per student week for operation as related to the average cost, $1.35
—○— Cost per student week for maintenance as related to the average cost, $1.11
—··— Miscellaneous costs per student week as related to the average cost, $0.23
x Average cost line.
L-Low.
H-High.

mendable practice. To arrive at this conception, a ratio of geometrical deviation must be resorted to, *viz.*, divide $12.28 by $18.25 to ascertain the percentage of reduction necessary in school No. 9, or divide $3.70 by $2.27 to get the percentage of increase necessary for school No. 8 to approach the average. By reference to column 3 of the table, it is seen at once that the first school spends 3.06 times the average, and the second only .38 of the average. The points are clearly shown in the charts as the extreme points of the continuous heavy curve.

In further disapproval of the arithmetical deviation in studies of this type, it may be said that when it is used only one curve may be drawn on a diagram unless a double scale is used. In plotting curves of ratios of geometrical deviation, everything relates to the average, which becomes 100 per cent or 1 as shown in the diagrams.

In this study it is found that schools No. 9 and No. 7 lie in the highest and schools No. 8 and No. 3 in the lowest fourth, which are "danger zones." The more general practice is indicated for the other five schools bracketed at the extreme left of each diagram. The schools falling within the middle half and the relative variation of the total cost per student week in each school from the average cost for all schools, are readily apparent from the diagrams.

THE ADMINISTRATION COST CURVE

In a similar way the deviations of the costs for administration in the various schools from the average cost have been computed as shown in columns 4 and 5 of Table II and the corresponding ratios plotted in Figure 1, Part A. To read this curve, observe that school No. 9 spends 3.93 times as much per student week for administration as is spent on an average school, No. 2 spends .56 of the average amount, while school No. 5 spends 1.37 times the average amount of 43 cents. Schools Nos. 9 and 7 spend the largest amounts, and schools Nos. 4, 2, 3, the smallest amounts and lie respectively on this score in the upper and lower fourths. The other four schools on the cost for administration lie within the middle half and have been so indicated by the bracket at the top of the chart. From this curve, therefore, it is possible to read from the same chart as that containing the total cost curve, the relative amount spent for administration as compared with the average amount so expended. In each case the "danger zones" and "safety zones" have been indicated.

THE OTHER CURVES

The ratios of geometrical deviation for the costs of instruction, operation, maintenance, and miscellaneous purposes have been computed in the same manner as the corresponding ratio for administration costs and the respective results tabulated in columns 10, 15, 20, and 25 of Table II, and used in locating the "zigzag" curves in parts B, C, and D of the graph. As these curves are interpreted in the same manner as that for administration on Part A, a discussion of them is unnecessary. In case two such curves are placed on the same figure, as in Part D, the middle-half zone for each may be indicated at the top and at the bottom of the chart.

THE RELATIONSHIP OF ANY CURVE TO THE TOTAL COST CURVE

A comparison between the total cost curve and any curve representing a function of expense for any institution gives the proportion going for that function as it is related to the average proportion for all schools combined going for the same purpose. Thus, in Part A, it is seen that the cost of administration in school No. 9 is 3.93 times the average cost of 43 cents, and that the total cost is 3.06 times the average total cost of $5.97. If the first ratio (3.93) is divided by the second (3.06), the quotient thus obtained (1.28) shows that the proportion going for administration in that institution is 28 per cent higher than the average. Such quotients have been termed *geometrical deviations from the total cost ratio* and are shown in Table II in paired columns, 6 and 7, 11 and 12, 16 and 17, 21 and 22, and 26 and 27. The first column of each pair contains those deviations which are less than unity, and the second column those which are in excess of unity, and they are called negative and positive deviations respectively. It is seen, therefore, in the diagram (Part A), that the proportion spent for administration is higher than the average in schools Nos. 9, 7, 5, 6, 3, and 8, and lower than the average in schools Nos. 4, 2, and 1. Schools Nos. 5, 1, and 3 spend about the average proportion. If all schools spent the average proportion, *viz.*, 7.2 per cent as shown in Table I, the dotted curve would coincide throughout with the total cost curve. The percentage variations from the heavy continuous curve indicate the magnitude of the deviations from the average practice.

It now becomes necessary to show that the *geometrical deviations from the total cost* curve express correctly the magnitude of the deviations as measured in the usual way, *viz.*, by computing the proportion of the total cost in each school going for the various functions of expense and comparing the ratios thus obtained with the corresponding average ratio for all schools combined. By referring again to Table II, it will be noted that the $18.25 spent by school No. 9 is distributed as follows: $1.69, or 9.3 per cent, for administration; $10.50, or 57.6 per cent, for instruction; $2.31, or 12.6 per cent, for operation; $1.35, or

7.4 per cent, for maintenance; and \$2.40, or 13.1 per cent, for miscellaneous costs. The average percentage spent for administration is 7.2, while the percentage so spent by school No. 9 is 9.3. It is evident that this school spends $\frac{9.3}{7.2}$ times the average. This ratio without question measures the geometrical magnitude of the deviation of this school's expenditures from the general practice. Therefore $r=\frac{9.3}{7.2}$. In determining this particular relationship from the graph we have assumed that $r=\frac{3.93}{3.06}$. If our assumption is correct, the first fraction equals the second, or

$$\frac{9.3}{7.2}=\frac{3.93}{3.06}.$$

If the amounts from which these four relationships were derived in Table II are substituted for them, the verification of the equality is at once apparent.

$$9.3=\frac{\$1.69}{\$18.25},\quad 7.2=\frac{\$0.43}{\$5.97},$$

$$3.93=\frac{\$1.69}{\$0.43},\quad 3.06=\frac{\$18.25}{\$5.97};$$

or substituting in the equation above,

$$\frac{\frac{\$1.69}{\$18.25}}{\frac{\$0.43}{\$5.97}}=\frac{\frac{\$1.69}{\$0.43}}{\frac{\$18.25}{\$5.97}}$$

or

$$\frac{\$1.69\times\$5.97}{\$18.25\times\$0.43}=\frac{\$1.69\times\$5.97}{\$0.43\times\$18.25}$$

or

$$1=1.$$

Thus it is shown that the ratios used in interpreting the graphs are equal in magnitude to the ratios usually employed in showing such relationships. It is unnecessary, therefore, to compute the percentage distribution of expenditures for each institution or even for all schools combined, as such comparisons are readily apparent from the graphs. For practical purposes it is not necessary to compute the percentages given in Table II, columns 8, 13, 18, 23, and 28. It has now been definitely shown that when the supplementary curves fall to the right of the total cost curve the proportion is higher than the average proportion so expended, and when such curves fall to the left of the total cost curve the proportion is lower than the average proportion.

THE SAFETY ZONE FOR PROPORTIONAL DISTRIBUTION

Conditions may make it undesirable for a school to lower its total cost per student week, but a readjustment of the distribution of costs may be feasible. Thus, it may not be possible for school No. 9 to lower its average cost of $18.25 per attendance week, since the school is very small, having only 1,558 attendance weeks during the year, and since the cost per student must remain necessarily high. The school also is located in a state where the winter is long and fuel costs are high.

The question, therefore, of a readjustment of expenditures is the only way in which the institution can conveniently conform to the more general practice of normal schools. The question now is: Does the school spend too high a proportion for administration as measured by middle practices? As previously pointed out, it spends 1.28 times the average proportion spent by all nine schools. Does this ratio fall within the "safety zone?" Upon examining column 7, Table II, it is found that three schools have greater percentage deviations than this, *viz.*, in school No. 8, 2.08; in school No. 6, 1.70; and in school No. 7, 1.33. Since there are nine schools in the list, the two having the highest ratios are placed in the upper fourth. These facts have been indicated on the diagram (Part A) by the letter "H" denoting "high." Upon examining column 6 of the same table, it will be noted that schools Nos. 4 and 2 expend the lowest proportions for administration and have been placed accordingly in the first fourth and marked "L" denoting "low." These facts indicate that the proportion spent for administration (1.28) by school No. 9, although considerably higher than the average (1), is still within the "safety zone." The limits of the middle half have been chosen half way between the second and the third highest and between the second and third lowest schools, and have been inserted in Table II, at the bottom of columns 6 and 7. Thus, on administrative costs a school may vary from .81 to 1.51 in its deviation from the total cost curve without being subjected to derogatory criticism. Corresponding actual and permissible deviations have been ascertained for the other functions of expense as shown in the paired columns 11 and 12, 16 and 17, 21 and 22, and 26 and 27 of the same table. For the sake of economy in printing, positive and negative deviations may be placed in one column. In the same manner, as explained above for "administrative" deviations, the "danger zones" for the other functions of expense have been marked "H" (high) and "L" (low).

WHERE TO BEGIN A CHANGE IN THE DISTRIBUTION OF COSTS

By observing all parts of the diagram simultaneously, it will be noted that school No. 9 spends relatively high proportions for administration, for instruction, and for miscellaneous costs, and relatively low proportions for operation and maintenance. Other things being equal, it should first reduce its miscellaneous costs, since on this score it falls decidedly within the upper "danger zone" (10.44). To come within zonal bounds this ratio must be reduced to at least 1.56. The next place to effect a reduction is in the cost of administration, since this curve (Part A) intersects the line representing school No. 9 at 3.93, while the instruction cost curve (Part B) intersects it at 3.69, indicating that the proportion spent for general control is relatively higher than that spent for teaching purposes. If this school must run at its present cost per student week ($18.25), it may be necessary to increase the proportion spent for maintenance, as this institution now spends its smallest proportion for this purpose as judged by the average proportion spent for this function by all schools. An inspection of the school plant may reveal the fact that repair and replacement work is badly needed. It may be that janitors are underpaid and that the proportion allotted for operation should be increased.

It can be seen from the graph that school No. 9 has a very high total unit cost ($18.25)—so high that a justification of it is rather difficult to make. No other school spends so large an amount. Why is it necessary to triple the cost of schooling to secure the advantage of a small institution? For administration this school spends almost four times as much as it costs in the "average" school. Possibly the principal receives a high salary, or perhaps the board of directors is well paid. The curves clearly show where the investigation of school costs should begin, if they have been correctly classified and reported. What causes the unusual expenditures for miscellaneous purposes? On this score only does this school fail to make a defendable distribution of costs, since it is the only point for this school marked "H" or "L." On maintenance costs this institution falls within the "safety zone," spending only 1.22 times the average for all nine schools.

In a similar manner the finances of the other institutions may be analyzed and questioned.

It is the duty of the statistician to lay the facts bare and to point out relationships as has been done in these diagrams; it is the function of an administrator or school surveyor to make suggestions for modifying the practice exposed or to justify the expenditures incurred.

It should be remarked that greater deviation from the general practice usually prevails where the function of expense is small, and less deviation where the function is large: thus on the cost of instruction it is not the common practice to spend less than .59 or more than 1.74 of the average as indicated by the upper middle-half zone in Part B, while for miscellaneous purposes the permissible range varies from .43 to 2.47 as shown by the lower middle-half zone on Part D. The same statement holds for the variation of the proportional amounts so spent. Thus, for instruction, a school may deviate from the total cost ratio only to the extent of .56 and 1.36, while for maintenance costs the corresponding permissible deviations range from .38 to 1.56.

With these explanations clearly in mind, it is seen that a multiplicity of relationships is unfolded in the diagrams. Two further comparisons also may be made. The costs in one school may be compared directly with the costs in another school by disregarding the average costs and middle halves indicated. For instance, school No. 7 spends more than school No. 2 per student week. In the former school, both the absolute amount and the proportional amount spent for administration per attendance week is greater than the corresponding costs in the latter. For the costs of operation of plant, the relative magnitude of these costs is reversed, school No. 2 spending more than school No. 7.

In case it is desirable to compare the costs in a school not represented in the graph with the costs in the nine schools chosen for this study, it is necessary only to ascertain the total cost and the cost for each function of expense per attendance week and to divide these quotients by the average costs for the nine schools represented. The costs in the additional school are then superimposed on the graphs—the total cost per attendance week in the school determining its position. Thus, if the total cost per week is found to be $10.00, a new "school" line would have to be drawn between school No. 7 and school No. 5 on each diagram. An added space can easily be conceived, but it is not necessary to an interpretation of relationships. The supplementary curves, representing administration, instruction, etc., would be "broken" between schools Nos. 7 and 5 to lead to and from the new point thus added to each part of the figure. The only disadvantage incident to such an addition is that the costs in the new school do not operate in determining the averages or the middle halves. If a sufficiently large number of instances are incorporated in the original drawings, the modification accompanying the addition of a single new school would not ordinarily materially affect the predetermined standards. In fact, it is often desirable to compare a school system or an institution with some related standard of which it is not a part.

THE MEASUREMENT OF LABOR PRODUCTIVITY

By P. Sargant Florence, *Bureau of Industrial Research*

Within the last five years a mass of writings has accumulated on the subject of labor turnover; more recently, absenteeism in labor has attracted attention and the two subjects have been recognized as closely connected. What has not yet been realized, however, is that parallel with these two "labor losses" goes a third, without which the usual statistical analysis and measurement of the efficiency of the personnel of an industrial plant is entirely lacking in final development. I refer to the possibility of an unduly low productivity on the part of the employee even when he is not "turning over" and not absent.

Probably this neglect of the final stage in ensuring personnel efficiency is due simply to the difficulty of measuring the degrees of loss involved. Labor turnover rates for the whole plant are now expressed in percentages of the average working force, and the hours lost by absenteeism are also quoted for the whole plant as a percentage of the total scheduled hours; but how can the actual degree of productivity in a multitude of different operations be a percentage of anything, or be quoted for a whole plant?

The question obviously is up to the statistician and until he solves the matter only the fringe of labor loss measurement is touched. For what is the use of a stable working force attending regularly if, possibly through very "staleness," the productivity of the individual man is low?

As in the case of labor turnover and absence, it is essential for the statistician to summarize the unit facts of any plant, or department, or operation, in such a way that the general showing of different plants, or different departments within a plant, or the different operations within a department can be compared fairly one with another. In fact, a coefficient is required of which the *numerator* gives the shortcoming of the actual showing from the maximum showing considered possible and of which the *denominator* gives some definite measure of such possibilities. Each plant or department or single operation is thus judged by the deviation from the possibilities of its own situation.

In the case of labor turnover, the coefficient adopted has as its numerator the annual number of men leaving or the annual number of men replaced (there are two rival schools of thought) and as its denominator the average working force during the year. In the case of absence the numerator is the number of man-hours lost and the denominator the total possible number of man-hours that could be worked according to schedule.

It is clear that the measure of absence is of the two the truer form of coefficient. The denominator gives the absolute possibilities which the numerator cannot exceed. In other words, the ratio can never have a greater value than 1, or 100 per cent. Moreover, the measure of *efficiency* (the attendance record) and the measure of *deficiency* (the absence record) are convertible, the one into the other. If Ab is the absence man-hours, and At the man-hours attended, and P the possible man-hours scheduled, $P = Ab$ plus At, and the absence coefficient $\frac{Ab}{P}$ can be derived from $\frac{P-At}{P}$.

The denominator of the turnover coefficient, on the other hand, gives only a rough indication of the absolute possibilities. We might assume that it was impossible for the whole working force of a plant to leave its employment more than once a day, supposing payment to be on a day-basis, not hourly. In that case the maximum possibility of turnover per year, assuming 300 working days per year, would be 300 times the working force, and the actual showing could be correctly expressed as a percentage of this. The average turnover has been found by the old method to have been in recent years around 200 per cent; stated as suggested, this would be equivalent to a coefficient of .66 per cent.

A LOW PRODUCTIVITY COEFFICIENT

Leaving aside the possible legitimization of the turnover coefficient on the lines of the absence coefficient, it is important that any *low productivity* coefficient that we may devise should start life in the right way. The possibilities of the situation in the matter of productivity (PP) must be known, and if the actual productivity (AP) is known, the coefficient of low productivity $\frac{LP}{PP}$ should be equivalent to $\frac{PP-AP}{PP}$ or $1-\frac{AP}{PP}$.

How is the ratio of productivity $\frac{AP}{PP}$ to be found?

The objective unit in which productivity is measurable directly is the output; its quantity as so many identical pieces per hour, or if the work is not "repetitive" as a speed of so many minutes per job; and its quality as so much scrap per hundred pieces, or so many minutes wasted per hour.

Output is definitely recorded in industrial plants as part of the ordinary routine for the following purposes among others: to watch carefully the routing of the work, to ensure work up to specification, to determine the amount of the piece-wages to be paid, and also as a pure measure of the efficiency of the individual employees even when these are on a time wage.*

These records of productivity, whether quantity or quality of output is in question, may be placed as follows in ascending order of detail:

1. Records of the productivity per day of a gang† or squad of men on the same operation. We shall refer to these as group-day records.
2. Records of the productivity per day of individual men. We shall refer to these as man-day records.
3. Records of the productivity per hour of a squad or gang of men. We shall refer to these as group-hour records.
4. Records of the productivity per hour of individual men. We shall refer to these as man-hour records.

Records of types 1 and 2 are a usual part of plant bookkeeping, though the records are often destroyed after the lapse of three or four weeks. Records of type 3 are usually kept whenever scientific management has proceeded as far as the installing of a planning department, in order to schedule the routing and to follow the progress of the work. Records of type 4 are quite unusual as yet, and have to be specially demanded. Their collection, however, requires no disturbance of factory routine.

Certain indirect measures of productivity can also be used: for quantity of output the consumption of power in driving the machines, for quality of output the relative number of accidents. The consumption of power, be it noticed, only measures the output on machine work, while an accident, though undoubtedly the child of error in attention and faulty muscular coördination, just as is spoiled work, is by no means its twin brother.

The numerator of the ratio of productivity being manifest directly or indirectly in the actual showing of amount of output, speed of output, proportion of scrap, waste time and even consumption of power and accidents, how is the denominator indicating the degree of lowness of the productivity to be found? The word "low" gives us the clue. Lowness is a comparative word. The productivity must be low compared to productivity similarly manifested, but under other circumstances, and it is precisely some other "standard" production that must serve as our denominator.

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* H. L. Gantt writes: "If the conditions are such that we can plan out the work ahead of time, we will get a fair degree of efficiency by keeping individual records of the workmen and raising their day rate accordingly. As a matter of fact, a better efficiency can be obtained by this method than by the ordinary system of piece work, where the rates are set by past records or the estimates of the foreman."

† "Gang" is used to denote several men coöperating or combining on the same job; "squad" to denote several men working singly on similar jobs.

How can a standard productivity be obtained?

Scientific management's time study will probably suggest itself immediately. Here is precisely a study whose main object is to find a humanly possible speed of operation that shall be a standard on which to calculate routing schedules, costs, and the piece rates premiums, or bonuses that are paid to the worker. The actual output is usually compared with this standard and a percentage efficiency worked out giving us, apparently, exactly the ratio of productivity we require.

But time-study is, so to speak, made *ad hoc*—specifically for one purpose, and it is often conducted only on one or two men during two or three short periods—probably too restricted a sample on which to judge the possible productivity of a whole group of men over their whole working time. The inadequacy of the time study in setting a standard productivity will be evident to practical statisticians when it is considered that those conducting these studies know nothing (or at any rate have published nothing) as to the relative productivity of the individual men and the particular time of day they select as samples, as compared with the possible productivity of the whole group of men and and the whole working period. Time-study men do not seem even to be aware that there is such a thing as a normal curve of error in abilities. To them apparently all men are equal and all times are equal; there is no problem of sampling; the productivity of any man and any time will do to represent the standard productivity of the whole.

It must be conceded that "scientific managers" are vaguely conscious of shortcomings in their method and usually the standard speed set is some 20 per cent below the actual time study results in order to allow for human nature. This allowance saves the system from a *reductio ad absurdum*, but the whole procedure can hardly be called scientific.

It is the aim of the following study to find standards of productivity that are based on a sufficient number of samples and which, especially, are not based on an experiment introducing unusual elements, such as the stop-watch. The sample in fact must be taken from the ordinary plant records that are collected as part of the plant activities.

In fact we must use for our "standard" denominator precisely the same sources of information and the same plant records as we did for our numerator giving the actual showings. But these records—output records at any rate, as we have listed them—are of several different types: group-day records, man-day records, group-hour records, man-hour records. It would obviously be valueless to compare the productivity of one man or group of men at one time with the productivity of another man or group of men at an entirely different time. The standard productivity must be of the same nature as the actual showing. If we wish to estimate the comparative productivity of different times, we must cite the productivity for different hours or days of the same man or group of men; if we wish to estimate the comparative productivity of different men, we must cite their productivity at one and the same periods of time. We thus reach the conclusion that, in the present state of our knowledge at any rate, the nature of the standard productivity must vary according to the problem we have in mind and the issues involved.

Here we shall confine ourselves to two specific comparisons that are both presenting important issues in industry today:

A. How does a man or a group or a squad of men compare in the various hours of the working day with its own standard for the most productive hour? What is the comparative *hour* productivity?

B. How does any given man's productivity in a squad compare with the productivity of all the men in the squad? What in fact is the *distribution of productivity* among the men in a squad? What is the comparative *man* productivity?

The importance to industry of an answer to question A lies in the problems of the daily cycle of loss of practice and fatigue. Do the earlier and later hours of the day show diminished productivity, and if so, what is the precise diminution say in the first hour, the eighth hour, the tenth hour? Does a ten-hour day pay? What length of working day is it that gives maximum productivity? And so on.

Question B has also certain very practical bearings in industry. Even supposing that one man's or a whole squad's productivity does not vary greatly from hour to hour, it does not follow that productivity is up to standard possibilities. While the course of output is smooth as between hours, the whole general level may be low.

In fact if comparative hour to hour productivity serves us as an index of daily fatigue, a comparison of individuals' general level of productivity probably may serve as an index of a chronic fatigue that is not removed by a night's rest. It may serve to point out easily fatigued individuals—neurasthenics—who would possibly form a class apart on a completely lower level of productivity.*

Further, the measure of comparative man-to-man productivity may throw light on a somewhat different kind of consideration—the voluntary restriction of output. For how else will this restriction manifest itself than by reducing the individuals most capable of high production to a level of man-productivity lower than their natural capacities would admit?

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* That industry contains enough subnormal individuals to constitute a severe loss is definitely maintained by psychologists and physiologists, as may be seen from Dr. Spaeth's articles in the *Journal of Industrial Hygiene*. Dr. Spaeth even goes so far as to assert that neurasthenics form such a large part in any group of workers that it is impossible to speak of any average typical productivity to include all the men in the group.

In the following paragraphs we shall illustrate the methods of computing coefficients of hourly productivity and man-productivity from figures supplied by a recently issued *Bulletin of the United States Public Health Service.** The main purpose of this *Bulletin* is the comparison of the working capacity of the personnel in two plants, one working a ten-hour day, the other an eight-hour day, but both engaged in metal working and both of equal technical efficiency.

HOURLY OPERATION OUTPUT

The standard performance for any one operation against which to measure the hourly productivity which was used in the *Public Health Bulletin* was the maximum output shown by any one of the eight or ten working hours of the day as found on a whole squad after at least a week's test.

The following table is drawn directly from the *Bulletin*,† and shows the result of such a test on four "squads," each engaged on a different operation. Thus on the operation of rivet press, the third hour comes out as that of the maximum output and the actual average output per

TABLE I: COMPARATIVE MAINTENANCE OF OUTPUT—

Operation	Number of obser-vations	Starting time of shift	Period of study	(*a*) Number of units: (*b*) Index Numbers[1]	Average output observed each working hour	
					First	Second
Rivet press	64	7.30 a. m.	Oct. 13–30	(*a*)	630	663
				(*b*)	**91.2**	**95.9**
Roll coil	86	..do	....do	(*a*)	246	253
				(*b*)	**96.1**	**98.8**
Magneto taping	63[4]	..do	July 23–Sept. 24	(*a*)	435	471
				(*b*)	**92.4**	**100.**
Commutator loom	15[4]	..do	Oct. 23–Nov. 15	(*a*)	763	871
				(*b*)	**85.2**	**97.2**
Average index numbers					**91.2**	**98.0**

[1] Index number=percentage variation from maximum; maximum=100.

[4] Group days.

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* Studies in Industrial Physiology: Fatigue in Relation to Working Capacity. Comparison of an Eight-Hour Plant and a Ten-Hour Plant. Report by Josephine Goldmark and Mary D. Hopkins on an Investigation by Philip Sargant Florence and Associates under the general direction of Frederic S. Lee. *Public Health Bulletin* No. 106.

† Table I, pp. 32 and 33.

man per day for this hour (691) is expressed as 100, the average output of all the other hours being then expressed as a percentage of this "standard" productivity.

This standard, as we learn from columns two and four, is based on 86 "observations," *i. e.*, 86 man-days, extending over a period of two weeks, and cannot, therefore, be considered a "snap" judgment. It is a result of conditions existing on twelve different workdays and affecting probably some seven or eight* different persons, and the chances are that everything has canceled out except the fact that the productivity was that of the third hour.

The last column but one, giving the average output for all the hours of the day, may be considered to sum up the comparative loss by low productivity for each operation. The roll coil operation, for instance, shows 96.5 per cent as the average of the hourly productivities over the whole day, which means that the low productivity coefficient $\frac{PP-AP}{PP}$ (possible "Standard" productivity minus actual productivity showing, divided by the possible standard productivity—see preceding page) is for this one operation $\frac{100-96.5}{100}=3.5$ per cent, as measured on the hourly basis in the quantity of output.

EIGHT-HOUR PLANT, DEXTEROUS HANDWORK

Average output observed each working hour									Ratio of spells—second spell to first spell (in per cent)
Third	Fourth	Average for spell	Fifth	Sixth	Seventh	Eighth	Average for spell	Average for day	
691	[2] 654	660	653	642	651	[3] 616	641	650	
100	**94.6**	**95.5**	**94.5**	**92.9**	**94.2**	**89.1**	**92.8**	**94.1**	97
256	[2] 252	252	236	252	253	[3] 226	242	247	
100	**98.4**	**98.4**	**92.2**	**98.4**	**98.8**	**88.3**	**94.5**	**96.5**	96
451	[2] 448	451	456	455	452	[3] 431	449	450	
95.7	**95.1**	**95.7**	**96.8**	**96.6**	**96.0**	**91.5**	**95.3**	**95.5**	99
871	[2] 896	850	856	845	835	[3] 776	828	839	
97.2	**100**	**94.9**	**95.5**	**94.3**	**93.2**	**86.6**	**92.4**	**93.6**	97
98.2	**97.0**	**96.1**	**94.8**	**95.6**	**95.6**	**88.9**	**93.8**	**94.9**	97

[2] Period of ¾ of an hour; actual output multiplied by 4/3.
[3] Period of 1¼ hours; actual output divided by 5/4.

HOURLY PLANT OUTPUT

We may give in this way the comparative hourly productivity of several squads on various individual operations, but how can we jump from this to a measurement of the hourly productivity of the entire plant corresponding to the inclusive turnover and absence rates that are so freely quoted? The solution bears an obvious resemblance to the measurement of cost of living changes. There is the same difficulty of quoting one uniform figure for a multiplicity of different items—numbers of objects, weights, sizes, etc., and of so weighting the items that the composite whole will present a true picture of what is being measured.

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* The days are 12, the man-days 86. Men=86/12 on the average.

The difficulty of unifying the multiform products is settled just as in the case of cost of living changes, by the index number; the base for this index number (to be represented by 100) lies ready to hand in the hour of maximum output, and the hourly variations in each of the operations studied are expressed as percentage variations from this hour. It will be noticed that this plan bears an analogy to the older method used by the United States Bureau of Labor Statistics in forming index numbers, namely, to express the changes in the price of each commodity by a separate series of index numbers of its own, before combining the commodity prices. The newer method of adding all prices together in their original form before indexing would in our case give undeserved weight to those operations which happen to produce the greatest number of units per hour. Thus in Table I on page 295, if the number of units were added in their original form, the commutator loom operation, where 839 units are produced per group per day on the average, would have over three times the weight of the productivity on the roll coil operation, where only 247 units per man happen to be produced on the average. Yet commutator loom is not necessarily the more important item in the production of the whole plant.

The use of the maximum hour as the basis for index numbers may meet criticism on the score that the maximum is by nature an extreme, and that the procedure is as inconvenient as basing *price* index numbers, say on the inflated prices of 1864, at the end of the Civil War. To this the authors of the *Bulletin* answer as follows:

> "It is true that the use of the maximum . . . . is open to certain statistical objections. A [basis of] comparison must obviously not be subject to deviations of an extreme or violent character as a maximum may frequently be. It must offer some guaranty of a fair measure of stability. In the limitations of human working power such a guaranty is afforded in the present case. Spurts may for brief intervals occasion an extreme deviation, but since they do not in any operation last an entire hour, they do not raise any hour so greatly as to invalidate the use of the maximum as a standard.
>
> "That our output figures are not subject to high extremes and are sufficiently massed toward the maximum to permit its use as the standard of comparison is proved by the following figures. The total number of average hourly outputs contained in the tables of both plants and represented in our text by the familiar term "index

numbers" is 344. Grouped according to their variation from the maximum 100, the index numbers are distributed as follows:*

	Index Numbers
From 100 to 96	138
From 95 to 91	112
From 90 to 86	48
From 85 to 81	18
From 80 to 76	12
From 75 to 71	6
From 70 and below	9

> "Thus a very high proportion—73 per cent—of these hourly output figures is massed within ten points of maximum; the remaining 27 per cent tapers down to the index number 48. The maximum then affords a satisfactory statistical basis of hourly comparison."

The difficulty now presents itself of so weighting the index numbers that, when added, their total (or average) will form a complete and accurately balanced picture of the whole plant productivity. In measuring cost of living changes, budgets are obtained of family consumption and commodity prices are weighted in accordance with the relative consumption of those commodities. In our case a "budget" must be obtained of the plant operations either through a census of occupations within the plant or, if the factory is small, by personal inspection. These various operations found must then be grouped according to what is considered the most important factor. In the case of a study of fatigue, the important question was held to be whether the operations involved muscle-work or dexterity, or whether it was a machine-operation. Accordingly, in the *Public Health Bulletin* which was mainly concerned with fatigue, the proportion of each type of operation in the whole plant is ascertained. The proportions of the eight-hour plant, which were made the basis for comparison, were as follows: one quarter of the operations, muscular; one quarter, dexterous; one half, machine operations, of which half again were operations on the lathe or "hand-screw" type of machine.

These proportions established, several operations of each of the four types were selected for study and an average derived from them for each type.† Table I, given on pp. 294–5, shows how an average is obtained from the four individual operations studied for the dexterous type at the eight-hour plant. Since each type forms exactly one quarter of all operations in the plant, the unweighted average of the four type-averages gives a representative average for the whole plant.

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[*] For explanation of one additional index number not included here see p. 28 of the *Bulletin*.

[†] For the machine types an alternative plan is to use the power consumption records which would indicate variations in productivity in a uniform unit for all the different power-driven machinery.

The average "index number" for all the hours of the day on each type of operation in each factory is given below:

TABLE II: AVERAGE OF COMPARATIVE HOURLY PRODUCTIVITIES

Type of Work	Eight-Hour Plant	Ten-Hour Plant
Dexterous	94.9	91.6
Muscular	92.9	86.5
Lathe Machines	92.8	88.9
Miscellaneous Machines	95.3	94.0
Average for Whole Plant	94.0	90.3

As suggested above, these figures show the actual maintenance of productivity throughout the hours of the day and can form the numerator of the productivity ratio (AP). Averaging the four types of operation, the eight-hour plant is seen to have a low productivity coefficient $\left(100-\frac{AP}{PP}\right)$ of $100-\frac{94}{100}=6$ per cent; the ten-hour a low productivity coefficient of $100-\frac{90.3}{100}=9.7$ per cent.

Hourly Plant Accidents

Besides the quantity of output, the *Public Health Bulletin* presents hourly comparisons in great detail for accidents. Just as a direct measure of quality of output would have to present the units spoiled or scrapped as a proportion of the total amount of units of output attempted, so here in the case of the indirect measure, the accidents have to be related to the total amount of production. The investigators were not satisfied with absolute accidents per hour, but give the comparative accidents per given output per hour. The ratio of accidents to output for each hour is arrived at by expressing each hour's accidents and total plant output as a percentage variation from the average hourly accidents and output respectively, and for each hour, dividing the percentage accident variation by the percentage output variation.

The hourly total plant output used as a basis in calculating the hourly accident ratios lies, of course, ready to hand in the composite plant productivity described in the preceding section. Obtaining representative figures for the whole plant presents no difficulties either in the case of accidents. Where accidents are simply used as an indirect measure of the quality of output, the degree of seriousness of the accident is not significant. Few accidents are likely to have been purposely induced by the worker, and the severity of the injury thus controlled. In the majority of cases the seriousness of an accident is not correlated definitely with the seriousness of the original error on the part of the human being (if any), and thus accidents are of uniform weight where human efficiency and low productivity are under study. The precise basis of the standard efficiency is decided by the purpose in hand. For the purpose of finding the effect of longer or shorter working hours, the basis for the standard minimum risk should be the lowest accident ratio shown on the average by any one particular working hour. This average in its turn should be based on a sufficient number of man-days.

What this standard is can obviously be found only from the factory records—motion or time-study on real accidents is decidedly out of the question.*

COMPARATIVE MAN-PRODUCTIVITIES

It has already been suggested that a second type of comparison, the comparison of man-productivities, would throw light on some further vital industrial issues—the possible existence of accumulated fatigue and nervous exhaustion of individuals, and the possible existence of restricted output.

It is evident that the basis for a solution of these issues is a knowledge of the distribution of working capacities among individuals. In the absence of positive evidence, we must assume that the working capacity of employees in any plant follows the normal curve of error which has been found to hold true of man's physical and mental traits. The distribution will be symmetrical about its mode, which is here equivalent to the arithmetic mean and median, and for any given coefficient of dispersion will assume a definite curvature.

Now the existence of the industrial phenomena we wish to study will be manifest in departures from this normal distribution of man-productivities. The presence of neurasthenics or the chronically fatigued will be ultimately shown in an unduly large frequency in the negative productivity values, possibly even in a second mode on the negative side of the curve, the neurasthenics definitely grouping themselves around a lower level of productivity. The existence of restrictions will be manifest by a departure downwards from the normal level of man-productivity among those of higher capacities, and there will be a sudden check in the progress of the curve at a certain level of productivity (the limit or "stint" generally observed). This non-correspondence with the normal curve of error will result (1) in the curve's being truncated at the higher values on the positive side, *i. e.*, negatively skewed, and (2) in the narrowing of the range of variation between the more and the less productive, *i. e.*, a fall in the coefficient of dispersion. In the extreme form these results would amount to such a narrow distribution of values that one value would practically be stereotyped, and to avoid the unscientific emotions conjured up by the word "restriction," it is a wise plan to refer to this whole range of phenomena as "stereotyping."

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* It is, of course, always possible to devise an apparatus which shall reproduce the supposed essentials in accident causation without reproducing its injurious effects. See, for instance, E. S. Bogardus, "The Relation of Fatigue to Industrial Accidents," in the *American Journal of Sociology*, 1911.

Setting aside the effects of accumulated fatigue on comparative man-productivities for future consideration, we shall concentrate on devising a practical measure for the comparative loss involved by stereotyped production.

This measure to be practical must above all be intelligible and easily used by the ordinary employer of labor as also by the ordinary representative of labor.* We shall in consequence use the system of statistical measurements most easily grasped and most easily calculated, namely the Median-Quartile-Interquartile Range Group. This system of measurement has an additional advantage in that it discounts the extreme values which in the complex situation presented by industry occur so frequently for extraneous reasons.

For instance, in the following table, the lowest average output is some 124 pieces below the next lowest, whereas the interval between all other man-productivities is nowhere greater than 6.3 pieces. It is probable that some special condition is present, personal to this one low-producer without reference to general plant or operation conditions. An average of standard for this whole operation should not be unduly affected by it.

The theoretical disadvantage of the median as an average,† that a correct total cannot be obtained by multiplying the median by the number of items, is of minor importance if we are willing to waive absolute correctness in favor of general tendencies more likely to be correct in the long run. And absolute correctness is not so important where our main object is to measure the comparative efficiency or rather deficiency of different operations, departments or plants, as long as the same method of measuring is adopted in all cases compared. Further, in calculating his labor turnover, it does not matter much to an employer whether his rate is 120 per cent or 150 per cent per year, if his rivals have rates varying from 40 per cent to 80 per cent. In the present state of the science of personnel, we must be content if we can get but one step further in our comparisons than just "bad," "moderate," "fair," "good," "very good."

It was suggested that restriction of productivity will manifest itself in reducing the more capable individuals to a level of output lower than would "naturally be," *i. e.*, lower than a normal curve of error would admit. Let us make the conservative assumption that the productivity of the least productive half of the men is not affected by restriction. In other words, the average productivity of the lower half, *i. e.*, the lower quartile, remains the same.

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* One of the hoped for functions of a system of labor statistics in the plant is to form a basis for negotiation which both sides will be ready to accept as fact.

† The average is here used as the generic term to cover arithmetic mean, mode, median, etc.

We then have to find the average productivity of the most productive half of the men compared with that of the least productive half, *i. e.*, the percentage the upper quartile bears to the lower quartile, (A) under conditions of restriction, (B) under conditions where normal abilities have free play, the difference in the A and B percentages marking the loss in productivity due to restriction.

We can illustrate this method from tables published in the *Public Health Bulletin* (Chapter 4 "Stereotyped or Restricted Output") in which the average output of each man of a large squad is given for two similar operations, one at the ten-hour plant, the other at the eight-hour plant. Unless the operations are really of similar type, it is difficult to eliminate the tendency of the mechanical equipment to restrict output automatically. Thus if in one operation half the time is necessarily consumed by the actual contact of tools and material and this time cannot in any way be reduced by the worker, it follows that the possible increase in speed for the whole operation is physically restricted. Physical restriction will produce exactly the same divergence from the normal expected distribution of man-productivity as would voluntary restriction. Comparison of such a type of operation with, say, a hand operation, would fail to isolate the voluntary restriction.

With this caution in mind let us take the average outputs for the period December 31, 1917–January 17, 1918, of the twenty-one men "forming small end of base on lathe." These figures are given in Table 15 of the *Bulletin*. Arranged in order of magnitude the figures are as follows:

TABLE III: TEN-HOUR PLANT, OUTPUT OF STEREOTYPED OPERATION

FORM SMALL END OF FUSE ON LATHE

Order of Low Productivity	*Check Number of Man*	*Average Output per Day Dec. 31, 1917–Jan. 17, 1918*
1st	10484	700.4
2nd	10420	824.1
3rd	10493	830.2
4th	10358	831.0
5th	10468	832.5
6th	10353	833.1
7th	10551	833.4
8th	10365	833.4
9th	10355	835.0
10th	10489	835.3
11th	10505	835.5
12th	10366	836.2
13th	10361	836.9
14th	10367	836.9
15th	10560	837.0
16th	10547	837.3
17th	10496	837.9
18th	10440	839.1
19th	10384	840.4
20th	10510	846.7
21st	10508	851.1

The value of the lower quartile is the output of a worker coming, to be exact, fifth and three quarters in order.* If we wish to simplify matters as far as possible—an important consideration when appealing to business men—we may take the nearest *actual* worker, namely, the sixth in order. This is what was done in the *Bulletin* we are quoting from. The sixth worker has an average output of 833.1 fuses per day. By similar methods it was found that the value of the upper quartile (the output of the sixteenth worker on our list) was 837.3.

Now the question arises, what would have been the upper quartiles had the output not been stereotyped by any individual worker or, at any rate, not by one half of the individuals. Let us turn to the fullest example given in the *Public Health Bulletin* of a non-stereotyped operation of a similar nature, namely, "axle grinding on lathe," at the eight-hour plant (Table 17). Arranged in order of magnitude, the average daily outputs of the twenty-nine individual workers over the period studied were as shown in Table IV.

The quartile values quoted here are the output of the workers coming nearest to seven and three-quarters and twenty-two and a quarter, *i. e.*, the eighth and the twenty-second. These values are 382 and 408 respectively, the upper quartile being thus 106.806 per cent of the lower quartile.

In a non-stereotyped distribution of man-productivities on a lathe type of operation, then, the upper quartile may be expected to be 6.806 per cent above the lower quartile. Applying this expectation to the forming small end of fuze of lathe, the expected upper quartile

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* In calculating the position of the median and quartiles in a series of n items, the author has not used the orthodox formulae (as given for instance by King in his "Elements of Statistical Method," Edition of 1916) to wit: $\frac{n \text{ plus } 1}{2}$, $\frac{n \text{ plus } 1}{4}$ and $\frac{3\,(n \text{ plus } 1)}{4}$. When worked out in spaces along a line, it will be found that these formulae make the interquartile range enclose slightly more than half the total spaces. Thus for 21 item-spaces Q 1 falls at 5½, *i. e.*, exactly between the fifth and sixth spaces. Q 3 falls at 16½, *i. e.*, exactly between the sixteenth and seventeenth spaces, and the interquartile range encloses 11 complete spaces out of the 21 instead of 10½ as it should.

The formulae used by the author, which appear to be spatially correct, are as follows:

Median: $\frac{n}{2}$ plus ½

Lower Quartile: $\frac{n}{4}$ plus ½

Upper Quartile: $\frac{3n}{4}$ plus ½

In the case of the median, the author's formula gives the same result as the orthodox formula, but the position or rank of the lower quartile is raised by ¼ and the position or rank of the upper quartile reduced by ¼.

The difficulty has arisen owing to our practice of indicating any space along a line in language by the position of its further boundary point, which, actually, is half the space beyond the center of the space. Thus we speak of a child's being in his fourth year when actually his age is anywhere between three and four and averages three and a half. Hence, to indicate in language any space in an array we must always add half a space to the actual middle of that space.

TABLE IV: EIGHT-HOUR PLANT, OUTPUT OF NON-STEREOTYPED OPERATION

AXLE GRINDING ON LATHE

Order of Low Productivity	*Check Number of Man*	*Average Output per Day (Period Studied was Sept. 19–Oct. 13 and Oct. 29–Nov. 10, 1917)*
1st	4238	307
2nd	4287	347
3rd	4206	370
4th	4282	374
5th	4342	377
6th	4182	380
7th	4003	381
8th	4373	382
9th	4370	387
10th	4354	390
11th	4402	391
12th	4215	392
13th	4276	392
14th	4223	394
15th	4356	398
16th	4452	399
17th	4220	400
18th	4465	401
19th	4361	402
20th	4289	406
21st	4419	407
22d	4395	408
23d	4318	410
24th	4392	411
25th	4200	413
26th	4221	414
27th	4232	416
28th	4426	425
29th	4350	428

should on that operation be $833.1\times\frac{106.806}{100.00}=889.801$. Actually, however we found the upper quartile to be 837.3.

The most productive half of the squad on this "form small end of fuze" operation, therefore, lost. 889.8 − 837.3 fuzes per day by restriction, *i. e.*, 52.5. Since, however, we assumed the least productive half to lose nothing, the average loss over the whole group is $\frac{52.5}{2}=26.25$ fuzes per man for the whole squad.

The net average loss in productivity for the whole squad, calculated (according to the formula suggested above) in percentages of the expected upper quartile (the standard probability) is

$$\frac{1}{2}\left\{\frac{\text{Expected upper quartile}-\text{actual upper quartile}}{\text{Expected upper quartile}}\right\}=2.95\text{ per cent.*}$$

ENVOI

In conclusion a word must be said as to the value to sociology of industrial statistics of the type we have outlined. The term sociology is used not as a vague reference to general social righteousness, but in its etymologically correct sense of the scientific *study* of society. It is a common observation that even the calmest students of mankind are likely, when they reach our modern industrial organization, to go wild and to forsake the path of ordinary scientific process for a jungle of vast overshadowing "problems"—the "labor problem," the "trust problem," the "railroad problem." The setting of problems to one's pupils or to oneself is a sure method of progression, provided the problem can be definitely formulated behind a question mark;

**I. e.*, $\frac{26.25}{889.80}$.

but what exactly is THE question about labor, about trusts, about railroads? A treatise on modern industrial society seems either to confess a wholly perplexed state of mind or else to indicate a reversion to Euclidian geometrics. Probably both elements are present. The sociologist who had been content to describe the manorial economy, the organization of the town gilds, or the arts and crafts of the Senegalese, by piecing together his facts item by item, when he comes to existing conditions abandons the item as a basis and reverses the procedure. He starts from certain general ideas of what is, and when he strikes an item-fact that deviates therefrom, it is a "problem." And general ideas of what *is* are easily polluted by general ideas of what *should be;* hence any and every item that is simply wrong is a "problem," and the erstwhile sociologist is by this time a sort of Big Brother to us all as well as a deductive geometrist.

The only escape from the problem jungle is to go back to the item facts. It is true that modern society presents a plethora of items. Indeed we suspect that some brand of agarophobia was partly responsible for the resort to the "Problem". But it is just against this overwhelming multitude of item-facts that statistics comes to the sociologist's aid. Whenever the items have values that can be measured, the possibility of exact yet inclusive generalization is admitted.

Probably of all forms of modern society the industrial establishment or "plant" presents the greatest chance of collecting measurable items. What is it but its rigid standardization that is most complained of in modern industry? Yet is it not precisely standardization of conditions that social statistics sighs for? Once let the personnel of the industrial plant be regarded not as a tediously refractory part of an automatic mechanism, but as a social organism just as worthy of scientific treatment as the State or the Trade Union; once let the possibilities of a statistical study of its behavior be thoroughly explored, and more light will be shed on the reactions of mankind to its present admittedly difficult predicament than by an infinite solution of problems to their last Q. E. F.

PRICES DURING THE WAR

By Walter W. Stewart, *Amherst College*

In at least one field of economic inquiry the maker of predictions may be held responsible statistically. Since the invention of index numbers, any one who has ventured to forecast the movement of prices has taken the chance that later he may be embarrassed by the facts. Frequently during the war, men tried to predict the course of prices by using the Napoleonic period or the Civil War as analogies; or they showed that government price-fixing was futile as long as credit inflation continued. Now that we may look back on what actually happened, it would seem the very beginning of scientific wisdom to check up, to find out where we went wrong, and to get ready for the next prediction.

All the material necessary for such a checking up is found in the report of the inquiry conducted by the Price Section of the War Industries Board.* In fact, the material is so abundant as to discourage the ordinary reader; he will be impressed by the bulk of the fifty-seven bulletins in which the results are published, conclude that it was an important investigation, and decide to read them later. The results include the measurements of the month to month fluctuations in the prices of fifteen hundred commodities belonging to fifty different industries; an exhaustive study of government control over prices; and a comparison of the price movements in the United States with those in thirteen other countries. An inquiry so comprehensive cannot readily be summarized within the limits of a review. The best that can be done is to describe the plan of the inquiry, to indicate some of the ways in which it differs from other investigations into price movements, and to comment briefly on certain of the results.

The feature of the plan which made necessary the collection of so large a number of price quotations was the desire to secure satisfactory samples of prices of both materials and products for each of the fifty industries included in the survey. Merely for the purpose of measuring the change in the general level of prices, a smaller number of commodities might have been sufficient. But if, for example, one wishes to compare the cost of materials in a certain industry with the prices of the products, or to measure the diversity of price change during a general rise, or to explain the fluctuations of controlled and uncontrolled prices, then a longer list of commodities is necessary. In this latter range of problems the present inquiry makes its chief contributions. It is mainly a "statistical study of the internal structure of the system of prices," an attempt to "show how the various groups within the total system of prices have behaved."

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* History of Prices During the War. Summary. Wesley C. Mitchell. *War Industries Board Price Bulletins*, No. 1. Washington, Government Printing Office, 1919.

"Prices constitute a system in the literal sense that they are so connected as to make a complex whole. To understand the workings of this system at any given time and the change it undergoes from one time to another, it is necessary to trace the interconnections among the various parts of the system. These interconnections are numerous and varied in character. The whole system of prices is not a miscellaneous aggregate of simple commodities, but an organized combination of groups of commodities. The prices of articles within these groups have especially intimate relations with each other and the groups themselves cross each other in rather perplexing ways" (p. 92 of the *Bulletin*). An understanding of the behavior of these various groups is necessary also in order to determine the extent to which a general movement of prices is controlled from within.

The simplest explanations of price movements ordinarily use an oversimplified concept of the price-level. To regard a single series of averages of prices of commodities at wholesale as an index of the "price-level" has the convenience and the dangers of any other oversimplification. Its merit and its defect is that it reduces into a single figure the highly diverse fluctuations of prices, with the advantage that it makes possible the discussion of a general trend of prices and with the disadvantage that the monetary theorist seldom discusses anything else. Only occasionally does he recognize that this apparently simple "price-level" average is in fact the net result of diverse movements within the system of prices. And on those occasions he usually saves himself the necessity of measuring the actual diversity by means of an unverified hypothesis; he assumes, other things remaining equal, that whenever prices in one part of the system rise there must be in some other part of the system a compensating fall.

The study of price movements, however, is wider than the field of monetary theory. It may be convenient to regard the general purchasing power of the dollar as (mathematically) the reciprocal of the price-level, but it does not follow that all the general changes in the level of prices can be attributed (causally) to monetary phenomena. Therefore, without denying the existence or significance of the general movement as measured by the index of the price-level, the statistician also employs various devices which reveal the complexity of the changes taking place within the system.

One measure of the dispersion of prices furnished by this study consists simply in arranging the price quotations on a scale which shows the magnitude of their relatives for each year (p. 12). The purpose of this arrangement is to indicate the diversity of the fluctuations, entirely apart from any question of the character of the commodities. It shows "(1) that the total array of commodities is characterized by a high degree of concentration, (2) that the degree of concentration declines each year, and (3) that the point where most commodities are found moves higher in the scale of relative prices as the war goes on" (p. 21). The tendency of prices to scatter as they rise and to swarm again as they fall has been observed in other studies of price movements made by Professor Mitchell. Apparently there was greater dispersion of prices from 1913 to 1918 than during the Greenback period; prices, on the average, did not rise so high, but they scattered over a wider range. In 1865, when Civil War prices reached their peak, they were more closely massed around the point of densest concentration than were prices in 1918. It is not surprising that the dispersive influence upon prices of a World War which upset many international markets was greater than that of a war in which only the area of the Confederacy was isolated, and the Union States kept their contacts with the rest of the world. Further comparisons should be made between the degree of dispersion during these periods of rapid rise in prices and the more ordinary fluctuations of prices incidental to the business cycle. Such a study might not result in a formula of "normal dispersion," but it should yield some useful observations.

Another device is used to indicate the commodities which fell in price and those that rose the most. It consists of a list for each year of the fifty commodities showing the lowest relative prices and the fifty showing the highest. No very broad conclusions can be drawn from this because the list includes each year only 7 per cent of the entire list of 1,437 commodities. It does show, however, that a considerable number of chemicals kept high in the list throughout the war; that certain important commodities imported from neutral countries, such as rubber and coffee, are among the fifty "lowest"; and that some of the military essentials whose production needed to be stimulated rose to several times their pre-war prices.

This method of listing the highest and lowest touches incidentally on the matter of the price changes in imports and exports. "Imported goods are disproportionately numerous, not only among the articles that rose violently in price but also among those that declined" (p. 16). The reason that many of the important exported articles do not appear also on the list of the "highest" is chiefly because of the brevity of the list. For it is probable, from what we know of the foreign trade situation, that weighted indexes of the prices of imported and exported articles would show that during the war import prices rose less than the general level, while export prices rose higher than the general level.* Two forces were at work keeping down the prices of imports: first, the imports from Europe, which was the center of disaffection for price revolutions, fell off markedly; and, second, imports of important materials from South America and Asia, which were shut off from some of their former European markets, declined in price and constituted a greatly increased percentage of total imports. Exports, on the other hand, were made up of articles which rose rapidly in price. The expansion of exports before the United States entered the war consisted largely of war goods, whose prices had been bid up by the Allied governments. The extent of this rise is indicated, for example, by the way the index number for the metals group, which includes many exported war materials, ranged above the index for "All Commodties" throughout the period of large exports. For a history of prices during the war there is no topic more important than a study of the influence transmitted to us by our trade with the rest of the world.

The interest in this problem gives point to the comparison made of war prices in various countries. For the purpose of these comparisons special index numbers were constructed measuring the change in identical lists of commodities in each of the two countries compared. The price rise in the United States started later than it did in England or France, rose more slowly, and during the whole period kept to lower levels. An analysis of the causes for these differences will require a great deal of detailed information which can be interpreted only by one familiar with conditions in the countries compared. Even in times of peace, when price fluctuations in different countries tend to correspond, international comparisons are not simple. When the countries are at war and the governments are regulating imports and exports, subsidizing certain industries, and in various ways controlling prices, the complexity is baffling. This study makes a beginning in the analysis and furnishes a considerable part of the material needed for further investigation.

That government price control checked the rise in the general level of prices will not be questioned by those who believe that the control over the prices of basic materials was not necessarily neutralized by a bulge in prices elsewhere. The facts are that the commodities over which the government exercised price control were for the most part the very commodities upon which fell the burden of war demand; that as a group these prices were higher than other prices before the United States entered the war; and that they were very much more affected by the declaration of war than were the others. No doubt, the fact that the prices of the commodities ultimately brought under price control were already high "facilitated the effort to prevent a further advance or even to reduce prices" (p. 43). Yet, without price-fixing, there is no reason why these prices should not have continued to advance and along with them the general level of prices. The truth is, that a year after the first effects of price-fixing were felt—after twelve months of war and of financing by inflation—the price level stood exactly where it was when price-fixing began. Price control, working under the handicap of inflation, accomplished results which somehow must be given recognition by any theory which attempts to account for the price movements of the period.

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* This probability appears to be borne out by the index numbers for imported and exported commodities constructed by the Division of Analysis and Research of the Federal Reserve Board. So far, these index numbers have been constructed only for the years 1913 and 1919, but their position in those years gives some indication of how the prices moved during the war. When completed these new series will be especially valuable in a study of international trade, since they provide import and export price-indexes not only for the United States but also for several foreign countries. See *Federal Reserve Bulletin*, May, 1920. Pp. 499–503.

A summary of the foregoing in the form of a condensed narrative may indicate some of the causal connections. Prices in the United States began rising the middle of 1915, under the influence of large orders for war materials placed by England and France. This demand for export communicated to the United States the rise which had begun earlier over there. When the United States entered the war, prices were 60 per cent above their pre-war level; during the next four months they advanced 20 per cent. From that time until the armistice—sixteen months—the chief factor was price-fixing; the level of prices fluctuated within a comparatively narrow range and at the end was only 6 per cent above the point it had reached when price-fixing began. The causal connection lies partly in the fact that the goods first exported on a large scale were the same commodities that later became essential for winning the war, many of which were ultimately brought under price control. They were of sufficient commercial importance to exercise a dominating influence upon the price-level. Their rise before the entry of the United States into the war, their subsequent abrupt increase, and then their relative stability under regulation, pointed out the direction which the general level of prices tended to follow.

The question of how the Price Section measured these changes in the general level of prices—the method of constructing the "All Commodities" index number, remains to be considered. Without going into all the technical details it is desirable to compare this index with the index number compiled by the Bureau of Labor Statistics, for one of the points of interest is the close agreement in the results reached by the two. The question arises whether this agreement furnishes a mutual verification of results independently arrived at, or whether it rests upon similarities of construction.

In the opinion of Professor Mitchell, "the close harmony between the latter [the series compiled by the Price Section and by the Bureau of Labor Statistics] does not arise from similarity of construction. Indeed, the new series includes over four times as many commodities as the old and has a different system of weighting. That independent investigators, utilizing different data, and applying different methods should reach such similar results in a period of such extraordinary changes is one more welcome indication that it is possible to measure the fluctuations of the wholesale price level with substantial accuracy, and also that the more careful the measurements taken the better will they agree" (p. 29).

There are some important respects in which the two index numbers are similarly constructed. Both belong to the same general form of index number—relatives computed from weighted aggregates of actual prices. The method of weighting the separate commodities is not greatly different. The bureau uses the estimated amount of the commodity "entering into trade" in a given year, an estimate which has to be based largely on the figures for production; the Price Section uses production plus imports in the year 1917, apparently because it is the nearest equivalent to the amount "entering into trade" (p. 22).

In addition to these commodity weights, however, the Price Section uses a second set called "class weights." The use of these class weights and the larger number of commodities included in the Price Section Index constitute the main differences in construction. It is important, therefore, to inquire into the influence of these two factors.

The class weights were used in order that the influence exercised by each class upon the "All Commodities" index would be in proportion to their relative importance in the system of prices. That is, in case the weights for the separate commodities threw the scheme of weights out of proportion for purposes of measuring the general trend, the class weights would serve as a corrective. The influence upon the "All Commodities" index of each of the various groups after the class weights were applied is presented in the following table. There is also presented the influence of the corresponding groups on the Bureau's index number.*

Groups	*Price Section Per cent of Influence*
Food	45.5
Clothing	13.7
Metals	18.2
Fuels	7.6
Building materials	4.2
Chemicals	5.6
Rubber, paper, fibers	5.2

Groups	*Bureau of Labor Statistics Per cent of Influence*
Farm products and food	52.9
Clothing	11.6
Metals	9.8
Fuel and lighting	10.2
Lumber and building materials	7.7
Drugs and chemicals	1.5
Miscellaneous	5.9

The agreement in the proportionate influence assigned the various groups by the two methods of weighting is closer than appears on the face of the figures. Some of the differences in percentages are due to differences in classification of certain commodities and not to differences of weighting. Cotton and hides, for example, are placed by the Bureau in the Farm Products group, and by the Price Section in the Clothing group. If these commodities were transferred to correspond to the classification of the Price Section, the agreement of weighting between groups would be closer. Except in the case of the Metals group, the influence exercised by the various groups upon the two different "All Commodities" indexes is quite similar. In both, the aim is to assign to each group a weight which corresponds to the commercial importance of the commodities in the trade of the country —by slightly different methods they arrive at similar results. In fact, it is probable that the class weights bring closer agreement between the two series of index numbers than would exist in their absence.

There are also reasons why the 1,437 "commodities" carried by the Price Section as against the 309 carried by the Bureau (in the year 1917) result in only small divergences between the two series. In the first place, all the commodities quoted by the Bureau are also carried by the Price Section. These include all the leading raw materials which, because of their commercial importance, are assigned a very large percentage of the weighting in both series. Also, many

* The percentages given for the Bureau of Labor are for the year 1917, because that year is used by the Price Section as a base year for weighting. In the comparison, the following adjustments are made: (1) The Bureau's groups of Farm Products and of Food are combined and compared to the Price Section's group of Food; (2) the group of Miscellaneous is compared to the group of Rubber, Paper and Fibers because they contain many of the same commodities—rubber, paper, wood-pulp, jute and rope are in both and carry the larger part of the weighting—(3) the Bureau's group of House-furnishings is omitted altogether, because there is no corresponding group in the Price Section index; in the Bureau's scheme of weights it counts for only four-tenths of 1 per cent.

of the additional commodities are in classes which are commercially of less importance. The Price Section quotes, for example, 281 chemicals, 20 per cent of the total commodities carried, while the Bureau quotes only 18; but the influence of the chemicals in either case on the "All Commodities" index is limited by the small percentage of weight assigned it by the scheme of weighting. Furthermore, the larger number of commodities is partly explained by the fact that in many instances the Price Section carried a large number of price series for almost the same commercial product. In hides and skins, for example, the Price Section has 48 quotations and the Bureau only 3; in leather, the Price Section has 51 and the Bureau 4. Bituminous coal, for which the Bureau carries 3 quotations, counts in the Price Section as "15 distinct commodities each of which is represented by its own series of prices" (p. 4). This full representation of different grades and markets is indispensable for a complete study of prices in the industry concerned, which was the main purpose of the Price Section; but their inclusion as additional commodities could hardly be expected to exercise any considerable influence on the index for "All Commodities."

The conclusion, then, to be drawn from this comparison is that the Price Section index number is constructed along lines sufficiently similar to those of the Bureau of Labor Statistics, so that their agreement in results cannot be regarded as furnishing independent verification. It is perhaps unnecessary to add that the two series are the best index numbers yet constructed, and that independent verification is not necessary in order that one may have confidence in them both.

Both series, however, still leave something to be desired. In fact, the agreement between the two is partly due to a shortcoming common to them both. Both series probably overstate the degree of fluctuation in the general level of prices. This is due to their under-valuation of the importance of manufactured goods in the system of prices. This difficulty cannot be avoided at present by gathering additional quotations, because the information concerning the prices of these goods is not available. But one of the functions of a system of weights is to overcome if possible such unavoidable shortages in quotations.

The class weights used by the Price Section do not accomplish this because the weight is applied to the price aggregates for the whole class, without distinguishing between the raw materials and manufactured goods. In establishing the class weights, allowances were made for "the value added by manufacture," thus tending to increase the relative importance of those classes composed largely of manufactured commodities. But the class weights did not increase the importance of manufactured goods *within* the class, or give to the prices of those goods any separate or special influence on the index for "All Commodities."

Special index numbers for manufactured goods were constructed for a number of different industries and published in the class bulletins. They show that the prices of manufactured goods fluctuated within a narrower range than the prices of raw materials. It is probable, therefore, that if a scheme of weights were used that gave to manufactured goods the importance they deserve, that the index number would show a less marked increase. We cannot now measure the precise degree of this exaggeration, but it is desirable to make allowance for the fact when discussing problems of general price change. The inclusion of a large number of heavily weighted raw materials may have the advantage of making index numbers more sensitive barometers. It also has the disadvantage of overstating the actual range of fluctuation.

Improvements in the methods for measuring the general change in prices is only one, and perhaps not the most important, of the still unsolved statistical problems concerning price fluctuations. Professor Mitchell in closing his Summary gives a list of topics requiring further investigation. The inquiry by the Price Section has succeeded in making "two problems grow where one grew before," and it has furnished the statistical material necessary for working on both problems. Any one interested in the study of price movements should see to it that he has the whole set of 57 bulletins. They will stand as the fullest collection of information about prices for a period which is unequalled in the complexity of the causes influencing price fluctuations.

CONTROL STATISTICS OF COAL PRODUCTION AND DISTRIBUTION

By F. G. Tryon, *United States Geological Survey*

The high prices of coal which have prevailed in the United States since the withdrawal of the government maximum prices on April 1, 1920, and the apprehension of a fuel shortage voiced both in this country and in Canada, have lent new importance to statistics of coal production and distribution. This article is an attempt to discuss what may be called the "control" statistics of the soft-coal supply. For many facts about the coal industry, such as labor, wages, mining methods, reserves, costs, investment, and profit, annual measurements are frequent enough, and the discussion of these subjects will not be attempted here. But the facts of production and distribution change so swiftly that monthly or even weekly and daily measurements of their broader aspects are necessary for intelligent planning either by the industry or by the government. To prevent misconception, be it said at the outset that "*control statistics*" is here used as a technical term and has no reference to government regulation. It connotes not statistics to control the industry, but rather operating records by which the agencies interested in coal production and distribution—operators, miners, railroads, dealers, and consumers—may guide their work. The need for operating statistics of the coal industry is always with us, but at a time like the present it becomes imperative. Decisions of policy, such as the laying of an export embargo, and the execution of specific plans formulated to carry out the policy, require accurate records, promptly available, of how coal is moving from mine to market. There is every prospect, moreover, that the need for such operating records will be acute for months to come. Overcoming the transportation disability which has been the limiting factor in coal production since the coal strike of 1919, and rebuilding consumers' stocks of coal will take months. The complicating factor of the demand for export overseas, which though not the prime cause of the present high prices has yet had a disturbing effect on the distribution of the coal produced, is likely to continue for years. As long as it does, even superabundance of coal in the interior will not solve a recurring problem of distribution at tidewater points—a problem which will require accurate statistics available at frequent intervals.

For the sake of brevity, bituminous coal only will be considered in this paper. This is not because anthracite plays an unimportant part in the economy of the country, but rather because the anthracite industry has at length achieved a condition of stability. Anthracite, though exported in large amounts to Canada, is not shipped overseas in significant quantities, and its market in the United States is confined to 23 states in the North and East. The reserves underground are limited, the production is relatively constant, and its distribution and consumption present few new problems. The mining of anthracite yields a major product, the domestic sizes, and a by-product, the fines or steam sizes. The one cannot be produced without the other, and the problem of anthracite distribution may be summed up in the statement that there is a chronic shortage of the domestic sizes and a chronic over-supply of the steam sizes.

In sharp contrast to anthracite, bituminous coal is mined in thirty states and produced in bewildering variety. Each field has its own market, determined by the quality of its coal and by the freight rate, and the competition between fields is keen. Bituminous mining is normally beset by an uncertain demand. Most fields are affected by a seasonal fluctuation in demand, and all respond quickly to changes in the general tone of business. When the market is active, a shortage of transportation usually develops, and as a mine runs only when cars are available, its output varies greatly from day to day. These factors make the distribution of bituminous coal a complex and ever-changing variable which must be measured at frequent intervals.

PRODUCTION

The subject of production is treated in the weekly coal report of the *United States Geological Survey*, begun by C. E. Lesher in July, 1917. Weekly estimates of the total production of anthracite and bituminous coal and beehive coke are published, based in each case upon statements of the number of cars loaded by the railroads, collected either direct from the roads themselves or through the American Railroad Association. As the great bulk of the coal not converted into beehive coke at the mines is loaded into railroad cars for shipment, these figures furnish a solid basis upon which to estimate the total mine output. A formula is used which seeks to take into account the tonnage shipped by water, burned at the mines for steam and heat, sold to local trade, used at associated manufacturing plants without transport, or carried by certain small roads not reporting.

The estimates are published in a preliminary way within one week of the period represented. They are usually revised at least twice, as more complete data become available, and then stand as the accepted figures of production until the results of the annual mine canvass are known, at which time it is possible to check the results obtained by the formula against the total mine production ascertained by actual count. Experience indicates that the margin of error in the figures of weekly production probably does not exceed 2 per cent. In 1918, for example, the sum of Mr. Lesher's weekly estimates, published January 4, 1919, was 585,883,000 net tons of bituminous, and 99,473,000 net tons of anthracite. The mine canvass completed six months later gave a final figure of 579,386,000 tons of bituminous, and 98,826,000 tons of anthracite. The error in the estimate was thus for bituminous, 6,497,000 tons, or 1.1 per cent; that for anthracite, was 647,000 tons, or 0.7 per cent.

The statistics of total weekly production may be regarded as adequate. We need also, however, at least monthly statistics of production by states and by fields. It is not enough to know the total output, for a shortage in one locality may exist simultaneously with a surplus in another, and yet because of transportation difficulties the surplus may be unavailable to meet the shortage. Furthermore, there is as great a variety of coals as of cloth, and it frequently happens that coals suitable for a special purpose may be in short supply when an abundance of fuel for other purposes exists. A feature of the coal market in the Northeast throughout the present year has been a scarcity of coals suitable for gas manufacture, and at seaboard a scarcity of the low volatile coal. It follows that current statistics of output, by fields, will at the same time yield a measure of the output by grades of coal. In an attempt to meet the need for current production statistics, by localities, the *Geological Survey* has begun the publication of monthly estimates of production, by states based upon railroad shipments. Certain technical difficulties in separating between one state and another the tonnage of coal originated on railroads loading in more than one state must be overcome, however, before the estimates can be brought to the accuracy desired.

For ordinary purposes weekly statistics of production are sufficiently frequent. At times, however, daily statistics become necessary, as was the case during the bituminous coal strike of November and December, 1919. Happily, the raw material upon which to base such estimates is at hand in daily telegraphic reports of coal loaded by the principal carriers which are received by the American Railroad Association. From these it is possible to approximate the tonnage of coal produced on a given day within 66 hours of the close of work on that day.

FACTORS LIMITING PRODUCTION

Of scarcely less importance in intelligent direction of the industry are current statistics of operating conditions at the mines which will isolate the factor limiting production in each district, and thereby make possible the application of remedial measures. Pioneer work in this direction has been done by Mr. Lesher of the *Geological Survey* in the system of weekly mine reports established during the war and maintained since. The arrangement is purely a voluntary one which has, however, received generous support from producers of coal. Each mine is asked to report at the end of the week the number of hours it has worked, and the number of hours it was shut down, the latter distributed among various possible causes of loss, rail transportation disability, shortage of labor, strikes, mechanical breakdowns in the mine, lack of orders, or other causes. The mine reports are assembled with the assistance of local operators' associations and forwarded to the *Geological Survey* at Washington. In districts where no association has been organized, the mines report direct to Washington. The work of tabulation and analysis is the only part of the task performed personally by the staff of the *Survey*.

The time worked and lost at each mine is weighted by its hourly production and the results are averaged and expressed in percentage form, district by district. Because of the large number of individual statements to be assembled and tabulated, it has been found impracticable to publish the returns before two weeks after the period they represent.

The weekly operating reports have established their usefulness as an indicator of the particular factor to which attention must be directed if production is to be brought to a maximum. They are essentially control statistics, possessing incidental value as permanent records, but chiefly useful as a barometer of change from week to week. It is unsafe, for example, to cumulate the losses attributable to a particular factor from one week to the next. Elimination of one factor limiting production may bring into play others whose influence has hitherto been obscured by the first.

Useful as are the weekly operating reports, there are many points in which the present system of obtaining them is subject to criticism. Since the Fuel Administration went out of existence, it has been possible to secure reports from only about 3,000 out of the 7,000 commercial mines, or from approximately 60 per cent of the total tonnage. The returns actually received are believed to be so distributed as to be fairly representative. More complete returns are, however, greatly to be desired, especially as the statements based on these figures are widely accepted as a measure of the service rendered by the railroads in supplying cars for the operation of the mines, a subject of frequent controversy between the producers and the carriers of coal. A still more important criticism of the present system is that it provides no way of checking the accuracy of the statements submitted by individual operators. The temptation to exaggerate the extent of a car shortage is strong, and in the interest of accuracy some arrangement is desirable for periodical inspection of the reports in the field, and for a systematic checking of the statements of the operators against the records of the railroads themselves.

Distribution

A current record taken at monthly and in some cases even weekly intervals of the movement of coal from mine to consumer, is important even in normal times as a guide to both the shipper and the purchaser of coal. Comparisons of the present movement with records in preceding years will show whether coal is being shipped into a particular locality in normal volume or not, a fact which is of value to the purchaser in laying plans for buying coal, and to the shipper as a guide to his selling campaign. When the market becomes disturbed and methods of controlling distribution are being discussed, a record of this movement becomes an imperative public need.

The importance of distribution statistics can be made clear by an illustration: A cause of much concern in the present coal year has been a sharp decrease in the movement from the Northern Appalachian region to Lake Erie ports, for transshipment to the head of the Lakes. Now the Northwestern states draw their supply in part from the Lake docks, and in part from the mines of the Middle West, particularly Illinois. To know whether there will be a shortage of coal in the Northwest next winter, it is not sufficient to watch the Lake shipments alone. A current record must also be kept of the quantity of coal shipped north, past Chicago, from Indiana and Illinois. For to the extent to which the latter fields are increasing their shipments to the Northwest, a decrease in the Lake tonnage may be viewed with equanimity. The illustration is a simple one, and is only one of many that might be cited. Regardless of whether the readjustment of distribution be accomplished by the trade itself or by quasi-public control, a record of the principal facts from week to week is a necessity.

Two methods of recording distribution present themselves, both dependent upon the records of the railroads. The first and most complete is to assemble copies of the waybills for every car of coal shipped, and to tabulate and analyze them in some central office having jurisdiction over all the roads in a given locality. Excellent work of this character is now being carried on by the Ohio Bureau of Coal Statistics, a railroad organization with headquarters at Columbus. Although the results obtained from working up the waybills of coal loaded are accurate in a high degree and susceptible of presentation in great detail, a month or two must elapse before the figures become available. The advantage of the second method of measuring distribution lies in the promptness with which results can be made public. It consists in holding up the stream of coal on wheels at critical gateways and junction points, establishing, as it were, gaging stations for the measurement of the rate of flow. An example of such gaging records are the figures of cars dumped daily over tidewater piers at the North Atlantic ports. Like the first method, this depends upon the coöperation of the railroads or of the coal exchanges where such organizations exist.

A third method of collecting distribution statistics, which may be used where no records are kept by the railroads, is to assemble statements from the operators themselves through their local associations. To make the record really valuable, however, it must be complete, and completeness is difficult of attainment for an operators' organization, membership in which is never compulsory.

The part of the government in preparing statistics of distribution should, it is submitted, be confined to coördinating the work of private agencies and supplementing it where necessary. At present distribution statistics are available covering the following major movements:

(1) Rail movement through Hudson River gateways to New England—weekly

(2) Cars dumped over tidewater piers—daily and weekly

(3) Disposition between coastwise, bunker, and export of coal handled at Charleston and Hampton Roads piers—weekly

(4) Same for all Atlantic ports—monthly

(5) Exports from Atlantic ports, by country of destination (lately established by the Department of Commerce)—weekly

(6) Cargo and bunker fuel dumped at Lake Erie ports—daily and weekly

(7) Destination of same—monthly

(8) Coal passing through Sault Ste. Marie canals—monthly

(9) Coal received at head of Lake Superior—monthly

(10) Exports to Canada—monthly

(11) Detailed distribution statistics for coal mined in Ohio—monthly

(12) Details of westbound movement from the "Crescent," Western Pennsylvania, West Virginia, and Eastern Kentucky—monthly

(13) Distribution records, more or less complete, kept by operators' associations in Indiana, Illinois, and the Rocky Mountain States—weekly or monthly.

This system of distribution records requires extension and supplementing as follows:

(1) More complete figures on rail movement to New England—weekly
(2) Complete weekly figures as to disposition of coal dumped at tidewater
(3) Shipments by car ferry to Canada—weekly
(4) All-rail exports to Canada—weekly
(5) Shipments westbound from the docks at the head of Lake Superior and Lake Michigan, by destinations—weekly
(6) Complete detailed statistics of distribution from Indiana and Illinois and Western Kentucky—monthly
(7) Same for Northern and Middle Appalachian region not now covered—monthly
(8) Same for Southern Appalachian, including Alabama—monthly

With these statistics at hand, a comprehensive picture of the distribution of bituminous coal in the territory east of the Mississippi and Missouri—the part of the country where a distribution problem can be said at present to exist—would be possible. As pointed out above, the work can be done most successfully by the railroads and the operators' associations, the government confining its activities to coördinating the reports of other agencies and occasionally to collecting the details where no local agency exists. The Fuel Administration's records of distribution during the war period furnish a background against which to measure present performance in the distribution of coal. That the government must itself undertake the final collection and analysis of the results is clearly indicated by the jealousies between shippers and carriers which militate against the free exchange of information between them. The total cost to the government of obtaining these distribution figures would probably not exceed $10,000 a year, if the work were carried on in conjunction with other studies of coal production and distribution.

Stocks

The subject of consumers' stocks of fuel is almost a virgin field. Prior to the war it had remained entirely unexplored. Yet when a sufficient store of data concerning stocks is available for comparison, stocks are likely to prove the most significant single barometer of the coal supply, for stocks constitute the consumer's reserve against an interruption to his line of communication.

In the United States it is not customary to store coal above ground at the mine, nor is there any present indication that the practice will be adopted in the future. It has been aptly remarked that the cheapest place to store coal is underground in the coal bed. Every rehandling of coal adds greatly to the cost laid down at the consumer's door.

Furthermore, since the limiting factor in times of fuel shortage is almost always transportation, accumulations of mined coal at the mine mouth would avail but little. What is wanted is coal at the factory, not coal at the mine.

The quantity of fuel which is available for use at any one time thus consists of the coal en route and of the coal already in the hands of the consumer. The first is a sort of mobile reserve; it comprises the coal on wheels and the coal held on the commercial docks at the head of the Great Lakes and at New England tidewater points. The coal on wheels is a more or less constant quantity, like the raw material in process at a manufacturing plant. While the docks at the head of the Lakes constitute the greatest coal-storage plant in the world, with a capacity of 15,000,000 tons of bituminous coal, the quantity on hand at the docks varies greatly from summer to winter and should, therefore, be excluded from figures of consumers' stocks, if it is desired to make them comparable. For this reason the dock coal is regarded as a part of the coal in transit rather than part of the commercial stocks.

At many establishments it is the practice to carry small stocks and to depend chiefly on the mobile reserve of coal in transit. It is this type of plant that is the first to suffer in a sudden tie-up of transportation, such as may be caused by a great storm or by a railroad strike. Storms like those of the winter of 1917–1918 are hurtful because they make unavailable the mobile reserve. The suffering at such a time is due not so much to a stoppage of production at the mine as to an interference in the delivery of coal already loaded.

Stocks, therefore, are a very useful barometer of the coal supply. They are the final proof of whether or not production has been keeping pace with consumption. Other things being equal, very large stocks are a sign that the market has been oversupplied and forecast a season of low prices. Depleted stocks, on the other hand, show that production has fallen behind consumption and forecast a period of active demand and consequently of high prices. Data on stocks would, therefore, furnish a fact basis for the ordinary commercial transactions of buying and selling coal. Moreover, in formulating a program of distribution, a knowledge of consumers' stocks is indispensable. When in June, 1920, representatives of New England and of the Northwest appeared before the Interstate Commerce Commission, praying for priority in the distribution of the limited quantity of coal then being produced, the most significant test of the solidity of their claims was the general level of stocks in the two localities.

The task of taking a complete count of stocks is very great. The number of commercial consumers was found by the Fuel Administration to exceed 90,000. Only a large statistical office, devoting its primary attention to the maintenance of a mailing list of commercial consumers of coal, could hope to obtain a complete count of stocks and even then completeness would be purchased at the sacrifice of rapid publication of results. The very magnitude of the task suggests that better results could be obtained by sampling. An experiment in this direction, begun by the Fuel Administration in the first quarter of 1919 and repeated by the Bituminous Coal Commission in coöperation with the *Geological Survey* in June, 1920, indicates that by addressing a limited list of perhaps 5,000 representative consumers well scattered over the country, and ascertaining both stocks on hand and current consumption, it is possible to express the stocks in terms of weeks' supply, a common denominator for all localities, periods, and types of consumers.

Having obtained the average week's supply at the current rate of consumption, for the major groups of consumers, we may approximate the total quantity of coal in commercial storage by weighting the stocks of each group by their weekly requirements. Calculations of this sort are necessarily estimates and are subject to a considerable margin of error, but it is possible to check the results against the known production and the apparent consumption, taking into account exports and imports. Subjected to this test, estimates of total commercial stocks which were wide of the mark would involve sudden and erratic changes in rates of consumption which did not square with other facts of record. The following estimates of total commercial stocks from October 1, 1916, to June 1, 1920, built up from sample reports of weeks' supply, meet this test fairly well.

TOTAL COMMERCIAL STOCKS OF BITUMINOUS COAL IN THE UNITED STATES

OCTOBER 1, 1916, TO JUNE 1, 1920

(Net Tons)

October 1, 1916	from	25 to 29	million	probably	27,000,000
October 1, 1917	"	26 to 30	"	"	28,100,000
July 15, 1918	"	38 to 42	"	"	39,700,000
October 1, 1918	"	58 to 60	"	"	59,000,000
Day of the Armistice	"	62 to 64	"	"	63,000,000
January 1, 1919	"	57 to 59	"	"	57,900,000
April 1, 1919	"	38 to 42	"	"	40,400,000
March 1, 1920	"	22 to 26	"	"	[a]24,000,000
June 1, 1920	"	18 to 22	"	"	[a]20,000,000

[a] Subject to revision.

These figures, it may be remarked in passing, indicate the necessity of putting into storage some 10,000,000 tons of coal between June 1, 1920, and the following winter, a fact of great importance in fixing the amount of coal to be produced weekly and for which railroad transportation must be provided.

The collection of data on stocks is clearly a task for the government. Although the details of distribution can properly be recorded by the shippers and carriers of coal, consumers display a pardonable reluctance in divulging their stocks and requirements. It is believed that the time is ripe for a quarterly canvass of stocks in the hands of representative consumers. The results should be made available in preliminary fashion within a month after the date of stock-taking. The total cost of such a quarterly stock report would not exceed $10,000 per year.

REQUIREMENTS

In obtaining statistics of stocks, the most uncertain element in future requirements will be cleared up also. We are accustomed to speak of the extraordinary increase in fuel consumption during the war period, and of the slump in consumption during the year 1919. The figures of production for the two years, 1918 and 1919, are indeed startlingly wide apart—579,000,000 tons in the war year, and 458,000,000 tons in the year of reconstruction. But of the difference—121,000,000 tons—probably not more than 51,000,000 tons represented a variation in the rate of consumption, the larger part—70,000,000 tons—being changes in stocks. For during 1918 there was a net addition to stocks of 30,000,000 tons, and during 1919 a net draft on stocks of 40,000,000 tons. In other words, any one attempting to forecast requirements at the beginning of 1919 would have been more concerned with the stocks then on hand than with the depression in business activity, great as the latter was to prove.

The consumption of coal is a fairly constant quantity, except as affected by the seasons and by business depressions. We are constantly adding to our store of information concerning the normal seasonal fluctuation in consumption, but we cannot yet predict whether the winter will be cold or mild. The forecasting of business depressions is beyond the ken of the coal producer. However, given information as to stocks, a certain season of the year, and a healthy tone of business, the monthly consumption of fuel may be predicted with a considerable degree of success.

The experience of the Fuel Administration indicates that the best way to build up a budget of requirements is to make use of records of past consumption, with allowances for changes to be expected, rather than to ask each consumer of coal how much he is likely to need. The latter is not only burdensome and time-consuming, but in practice is likely to yield very unreliable results. The job is so big that no one ever tries it unless a shortage of fuel is believed to be impending; at such a time every consumer will overstate his requirements in the belief that the record will be used as a basis for allotting the limited supply of fuel, and the resultant inflation may be great. The subject of requirements is important enough to warrant the most careful study. It is a subject, however, where hindsight is as necessary as foresight, and progress is likely to be made in proportion as our information as to actual consumption of coal, by industries, by localities, and by seasons, becomes more detailed and exact.

PRICES

The importance of current records of prices is so obvious as to require no comment here. They are watched intently not only by buyers and sellers of coal, but as a measure of the social justice of the producers' profits. For this latter purpose the most satisfactory index is the average realization rather than the spot or market price. The great bulk of soft coal is sold under contract. Contracts ordinarily run for a year, beginning with April 1, the opening of the "coal year," and sometimes for two, three, five, or even twenty years. Although such long-term contracts usually contain clauses automatically increasing the prices, in the event of wage increases, the price charged per ton is much lower than the ordinary market price. The test of the operator's profit is, therefore, not the spot price which, during periods of scarcity, may be forced up to very high levels, but rather the average price of all of the coal which is marketed. The producers of coal have secured a temporary injunction restraining the Federal Trade Commission from imposing penalties for failure to supply monthly figures on realization and cost, but the Commission is still receiving a sufficient number of voluntary reports to enable it to keep up the record. As an index to the operators' return, these reports have great value and are properly to be considered as a part of the control statistics of the coal industry.

Quite apart from the social justice of a prevailing price of coal, prices have an immediate significance in coal distribution and consumption. The demand for coal is notably inelastic. As the ultimate source of most of our power and heat, it has no competitor or substitute on a large scale. In consequence even a slight maladjustment between demand and supply creates abnormal prices for free or non-contract coal. This principle is well illustrated by the experience of the spring and summer of 1920. During this season there have been few authenticated instances of plants actually closing down for lack of fuel, yet the difficulty of obtaining coal and the apprehension of a possible interruption of supply during the winter have induced purchasers to pay spot prices from 100 to 500 per cent above the government maximum. The minute prices reach such extravagant levels, inequalities and irregularities in the distribution of coal develop. Consumers, like public utilities, operating under a fixed return, cannot compete with prosperous manufacturers who are able to increase the price of their product and with whom, as often happens, coal is a minor item of expense. Even the prudent consumer, whose requirements are covered by contract, finds difficulty in securing deliveries on the contracts he holds. The result is that in addition to the general draft upon stocks, which occurs in a time of scarcity, some consumers run out of their supply long before others, and if a tie-up of transportation occurs, occasioned perhaps by a great storm, the results are much more serious than if the same amount of coal had been evenly distributed among all consumers.

The price factor may even go so far as to divert streams of coal from one locality to another. An outstanding feature of the coal distribution in the first half of 1920 has been an increase in the relative movement to Detroit and the Southern Peninsula of Michigan. Michigan consumers were indeed in need of fuel. Their reserves had been eaten into during the coal strike of the winter of 1919 as severely as those in any locality. But when it came to bidding for the limited output of coal in the Northern and Middle Appalachian region, the prosperous automobile makers and their train of subsidiary industries were able to get more than their proportionate share at the expense of the movement up the Lakes to the Northwest. A still more outstanding illustration of the effect of prices upon distribution is the diversion for export overseas, of tidewater coal which normally would move to New England. It is no doubt just to say that when New England really needs the coal she will pay the price and keep it from moving abroad, but the fact remains that under the stresses set up by price differentials, a condition of temporary shortage more or less severe, affecting a whole locality, has been brought about.

These illustrations point to the necessity of adequate "records of prices," including prices for free coal and also average realization figures, as a part of a well-balanced system of control statistics of coal distribution.

NOTES

INTERNATIONAL PRICE INDEXES*

The *Federal Reserve Bulletin* for May contains a discussion of the method to be used in the construction of a series of international price index numbers by the Division of Analysis and Research of the Federal Reserve Board. A new index number for the United States, which is the first of the series, also is published in that number of the *Bulletin*. Index numbers for England, France, Italy, and Japan are in process of construction. The first two will probably be published in the autumn.

Method of Construction

Each index number is to consist of approximately ninety different wholesale price quotations, the commodities to be classified (1) according to their stage of manufacture, as raw materials, producers' goods, and consumers' goods, and (2) according to their derivation and use, as goods produced, imported, exported, and consumed. The year 1913 is used as the base year. No attempt has been made to cover the war period. The same method of weighting will be used in the case of each index number. Prices of goods produced will be weighted by the quantity produced, prices of goods imported by the quantity imported, etc. All of the indexes are being planned and the computations made in this country in order to insure uniformity of method. Actual prices are collected abroad by consular agents and cabled to the Federal Reserve Board the first of each month. The index numbers will be published monthly for the preceding month.

The plan outlined above was developed after considerable study of the problem, both as to the ends to be gained in making a series of foreign index numbers, and the best methods for reaching these ends. The aims are three: first, to obtain better and more comparable indexes of the general wholesale price levels of the leading foreign industrial countries; second, to increase our information regarding the movement of prices of goods entering into foreign trade; and third, to classify the material in such a way as to throw as much light as possible upon current business conditions abroad.

A study of the indexes currently published abroad showed that in most cases they consisted of the prices of not more than forty-five commodities, most of which were raw materials or in a very early stage of manufacture, that all of the commodities quoted were given equal representation in the index numbers regardless of their importance in the economic life of the countries concerned, and that in some cases import and export valuations were used in computing the umbers instead of wholesale market quotations. The year or series of years used as the base from which to measure price changes differed in every case, so that it was necessary to recompute the numbers to make them comparable.

Obviously such indexes were not satisfactory either for showing accurately the general price levels of individual countries or for making comparisons between countries. Improvement could be made in the following respects at least:

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*The Division is indebted to Walter W. Stewart of Amherst College for making constructive suggestions regarding the organization and weighting of the index numbers.

(1) By including a larger number of quotations.

(2) By including not only raw materials but semi-manufactured, and manufactured commodities in them.

(3) By weighting the commodities according to their industrial importance.

(4) By using wholesale market quotations collected from reliable sources.

(5) By using the same base year for all countries.

Scientific work done in the field of international price comparisons had emphasized the fact that for comparative purposes it was important to have all the indexes approximately the same size and based upon the prices of the same commodities. Experimentation showed that the first point was essential, *i. e.*, that the index numbers should all be of approximately the same size. Otherwise, an unnecessary element of dissimilarity was allowed to influence the comparisons. The second point, namely, that the same or similar commodities form the basis of all indexes, did not appear equally valid for the reason that all countries differ economically one from another, and no single list of commodities represents them all equally well. Carefully matched commodities are essential for the purpose of comparing actual prices from country to country; representative commodities, on the other hand, are preferable as a basis for index numbers.

Ninety quotations (the number allowed for each of the new indexes) provides representation for all of the leading commodities of a country, is small enough to be a fairly sensitive barometer of price changes, and is not unnecessarily expensive. Such a number is big enough to prevent one commodity, or a small group of commodities, from influencing the final index unduly. It also allows a fair representation to commodities in different stages of manufacture and of different derivation and use. In respect to size, it marks a considerable improvement over existing index numbers.

A year ago, when the international price indexes were first planned, it was thought unlikely that sufficient foreign statistical material could be obtained in this country to furnish a satisfactory system of weighting for the proposed index numbers. The desirability of weighting the commodities according to their importance in the different countries was generally conceded. Fortunately, however, foreign statistics for 1913 were available in larger quantities than was anticipated, and as a result the method of weighting has become one of the most important features of the new index numbers.

In order to carry out the second aim mentioned above, namely, that of making index numbers which would facilitate the study of prices in their relation to foreign trade, it was decided to classify the commodities as domestic goods, imported goods, and exported goods. The method of weighting adopted suits this purpose excellently, as the prices of domestic goods are weighted by the quantity of goods produced in 1913, the prices of imported goods by the quantity imported, the prices of exported goods similarly by the quantity exported, and the prices of goods consumed by the quantity consumed in that year. The general index is made by putting together the weighted prices of domestic goods and imported goods. In other words, the method of weighting the all commodities index is that of production plus imports in 1913. The system of weighting may be expressed in the equation, goods produced + goods imported = goods exported + goods consumed.

An index number can be very quickly constructed and easily carried on if weighted in this fashion. Monthly index numbers are obtained by using the following formula:

Let $p_0 =$ the price of wool in any month
$p_1 =$ the price of hides in the same month
$p_2 =$ the price of cotton in the same month
etc. for other commodities in the index
Let $q_0 =$ the quantity of wool produced in 1913
$q_1 =$ the quantity of hides produced in 1913
$q_2 =$ the quantity of cotton produced in 1913
etc. for other commodities in the index
Let $i_0 =$ the quantity of wool imported in 1913
$i_1 =$ the quantity of hides imported in 1913
$i_2 =$ the quantity of cotton imported in 1913, etc.
Let $e_0 =$ the quantity of wool exported in 1913
$e_1 =$ the quantity of hides exported in 1913
$e_2 =$ the quantity of cotton exported in 1913, etc.
Let $c_0 =$ the quantity of wool consumed in 1913
$c_1 =$ the quantity of hides consumed in 1913
$c_2 =$ the quantity of cotton consumed in 1913, etc.
Then $\Sigma P Q =$ the sum of the prices in the chosen month of goods produced × the amounts produced
$\Sigma P I =$ the sum of the prices in the chosen month of goods imported × the amounts imported
$\Sigma P E =$ the sum of the prices in the chosen month of goods exported × the amounts exported
$\Sigma P C =$ the sum of the prices in the chosen month of goods consumed × the amounts consumed
Or $\Sigma P Q + \Sigma P I = \Sigma P E + \Sigma P C$ and the index numbers may be obtained by converting the money aggregates on both sides of the equation into relative numbers on the 1913 base.

The import and export classification is useful not only as showing the trend of prices in these two groups of goods, and thus throwing light on the relationship between foreign exchange, international trade, and prices, but it may be used also to correct the price factor in foreign trade statistics. The Federal Reserve Board has already begun to use the index numbers for the United States in this way, publishing for the first time in the *Bulletin* for July, 1920, a monthly index of the foreign trade of the United States based upon the trade in the commodities used in the export and import price indexes.

Classification of commodities according to stage of manufacture was made in order to facilitate the study of business conditions abroad, and to show the variations in the level of prices of raw materia's, producers' and consumers' goods. This method of classification will probably be of more interest to the student of economic conditions than to the business man. For one reason, the significance of the variations in the prices of raw materials, producers' and consumers' goods, and the meaning of the latter two terms are not generally understood. For the purpose of distinguishing between demand for goods for personal and family consumption and industrial demand either for equipment or raw materials, however, this classification is essential.

THE AMERICAN INDEX NUMBER

A demonstration of the type of information to be obtained from the new foreign index numbers is furnished by the American numbers published below:

AVERAGE PRICES 1913=100

Date	Goods Produced (72 Quotations)	Imported (18 Quotations)	Exported (39 Quotations)	Consumed (88 Quotations)	Raw Materials (39 Quotations)	Producers' Goods (31 Quotations)	Consumers' Goods (20 Quotations)	All (90 Quotations)
1913								
January	100	105	100	100	99	105	99	100
February	100	104	100	101	99	105	99	100
March	100	103	99	101	100	105	99	101
April	101	101	99	101	101	103	99	101
May	100	100	99	100	100	102	99	100
June	100	99	100	100	100	101	101	100
July	100	99	99	100	98	101	102	100
August	100	101	99	101	101	100	101	101
September	101	100	102	101	102	98	101	101
October	101	98	103	100	102	96	101	100
November	99	98	102	98	100	95	101	99
December	98	93	99	97	98	91	99	97
1919								
January	197	168	200	195	195	193	196	195
February	191	168	192	190	190	191	188	189
March	193	163	194	191	196	185	188	191
April	198	165	194	196	201	181	197	196
May	204	172	211	201	209	184	202	202
June	204	180	214	202	208	192	202	203
July	214	176	224	211	217	200	211	211
August	221	174	219	218	217	206	224	218
September	215	170	212	211	211	203	216	212
October	215	174	226	212	213	207	214	211
November	222	179	242	217	220	213	219	219
December	231	205	249	225	223	223	225	226
1920								
January	244	212	255	240	245	236	240	242
February	244	216	252	242	242	247	240	242
March	250	218	256	247	246	263	241	248
April	265	242	264	263	263	274	257	263
May	266	246	262	264	263	274	261	264
June	261	226	256	258	258	265	256	258
July	255	204	248	251	250	251	254	251

Interesting factors in the general movement of wholesale prices in the United States since the armistice have been so frequently discussed that it is not necessary to go into the subject here. Although the Federal Reserve Board all commodities index runs considerably lower than that of the Bureau of Labor Statistics, the fluctuations in the two numbers are in substantial agreement. For some time past, the Federal Reserve Board has classified the commodities used in the index number of the Bureau of Labor Statistics into these three groups and has commented on the differences in their price fluctuations from time to time. As in the case of the all commodities index, the new numbers fluctuate in substantial agreement with those of the Bureau of Labor Statistics, but the percentages are likely to run lower. This is especially true in the case of consumers' goods. Why this difference in price levels exists requires a more detailed comparison of the two index numbers than we have as yet been able to make.

Although much has been written about prices recently, comparatively little attention has been given to the difference in the flucutation of prices of domestic goods as compared with imported, or of imported as compared with exported. In this field the new index makes a contribution to the study of American prices. Since the period covered by these indexes amounts to only eighteen months (not including the base year), no definite conclusions can be reached regarding the significance of the fluctuations. It is too soon to attempt to correlate them with foreign trade movements, fluctuations in foreign exchange, or volume of production. A brief summary can be given, nevertheless, of the outstanding features of the three curves during the period covered.

Eighteen quotations are included in the index of prices of imports, thirty-nine in that of exports. It is somewhat unfortunate that the import index is not larger, but in view of the fact that the value of imports in 1913 was only about three-fourths as great as that of exports and far less important as compared with domestic production, larger representations could not be given to imported goods. Sugar, coffee, tea, hides and skins, wool, silk, cotton, rubber, nitrate of soda, tin, lumber, and several less important commodities make up the index, and their combined value in 1913 was 41 per cent of the total value of imports in that year.

Fifty-six per cent of the value of our exports in 1913 is represented in the commodities included in the index of prices of exported goods. These include our leading cereal crops, tobacco, cotton, copper, coal, pig iron and steel products, lumber, oil products, pork products, leather and shoes, cotton cloth, coffee, and other goods of somewhat less importance for export.

Prices of seventy-two commodities form the index of goods produced. Thirty of these are raw materials. Farm products provided something over half the total value of the group in 1913, products of mines and forests making up the rest. Twenty-four of the seventy-two commodities in the index are producers' goods, a little over 50 per cent of whose value in 1913 was provided by equipment materials, the rest being made up of such goods as yarns, leather, semi-finished foods, etc. Of the eighteen consumers' goods in the index, twelve are foods, and the rest materials used for clothing and lighting.

PRICES OF IMPORTS

January, 1919, to June, 1920, divides itself into three parts as far as import prices are concerned. The first period, lasting from January to September, 1919, was marked by a downward movement from January to March, a rise between March and June, followed by another reaction which left prices in September at approximately the same point as in January. Between September, 1919, and May, 1920, import prices steadily advanced, the increase amounting to as much, in terms of 1913 prices, as during the whole period of the war. The index number stood at 170 in September and at 246 in May; in other words, prices of this class of goods increased about 45 per cent. May, 1920, marks another turning point, as prices in June showed a twenty point drop from those of May. In July there was a further decline of 22 points.

Falling prices from January to March, 1919, are easily accounted for by the industrial depression following the signing of the armistice. The revival during the next few months, however, was not so great as the revival in domestic and export prices, and the steady drop in import prices between June and September was of longer duration than was the case with domestic goods. This period is difficult to account for, as imports during the same time were rapidly mounting, showing that our demand upon foreign markets was on the increase. Certain important commodities continued controlled in price, however, and the demand for at least one of our leading imports, nitrate of soda, declined.

The phenomenal rise in prices between September and May was caused by our heavy demand for sugar, silk, hides, wool, etc., and the accompanying speculation in these commodities. Release of sugar from price control was another important factor in the situation. By May, 1920, however, there was no longer a market for several of these commodities, notably silk, hides, and wool, although sugar continued to advance; and by June practically every commodity which we import in quantity, including sugar, had declined in price.

A comparison between the prices of imported and domestic goods during the same period shows that imported goods were 68 per cent dearer in January, 1919, than in 1913. In the same month the prices of domestic goods were 97 per cent higher than in 1913. In other words, in January, 1919, the index number for imports was 17 per cent lower than that for domestic goods. By May, 1920, imported goods had advanced so rapidly that they were only 7 per cent less than domestic goods, but by July the old disparity in prices of the two groups had been re-established, the index number for imported goods being 25 per cent less than for domestic.

Why imported goods were and have continued considerably cheaper than domestic goods is probably to be explained by the fact that most of the materials in the index are obtained from markets where prices did not advance during the war at the same rate as in the United States or in Europe. Argentina furnishes us with wool and hides; Brazil with coffee and rubber; Chile with nitrate of soda; India with burlap; and other portions of the Far East with silk, tea, and tin; Australia with wool; the West Indies with sugar; and Canada with lumber. With the exception of Japan and Canada, probably none of these countries experienced such price increases as the United States between 1914 and 1919. In the case of rubber and coffee, conditions peculiar to the industries kept prices low during the war. New rubber plantations had just reached the productive period when war broke out, seriously curtailing European demand. Production could not be adjusted to the new conditions, and prices remained low. Inability to adapt production of coffee to war conditions kept prices of this commodity below pre-war levels. Price control, American and foreign, may have been more effective in the case of our imports than of our domestic goods, but as no studies have been made of this subject, it is impossible to be certain of it.

PRICES OF EXPORTS

Export prices during the past eighteen months cannot be broken up into periods as neatly as import prices. After the depression of early 1919, they advanced rapidly until July, when a break came, the prices of cotton, wheat, corn, and other food products declining. From September until January prices rose even more rapidly than in the preceding spring, but in February a slight decline came again, this time in approximately the same commodities as during the summer before. Prices advanced again in March and April, but since then have been slowly falling.

Prices of export goods have been relatively higher than the average of domestic goods and the general price level most of the time between January, 1919, and June, 1920, although this has not always been the case. At the present time domestic goods and the general price level are relatively higher than exported goods. Although fluctuations in prices of export goods have usually preceded those of domestic goods as a whole, no general conclusion can be reached because of the shortness of the period and the peculiarities of trade during that time. As was mentioned above, the total rise in export prices between January, 1919, and May, 1920, was much less great than was the case with imported goods. The level of prices, as compared with 1913, was, however, both in January, 1919, and in June, 1920, very considerably higher than that of imported goods.

European and American war demand caused the prices of our export goods, which are some of our leading commodities for home consumption as well, to rise at a faster rate than imports. Prices of these and other important domestic goods had a far greater effect upon our general price level than prices of imports, as is shown by the similarity in the index numbers of goods produced and all commodities, and the dissimilarity between the latter and the index of imported goods.

DIFFICULTY OF GETTING MATERIAL

Comparatively little difficulty was encountered in the construction of the American index number, as a great many prices have been collected by the Bureau of Labor Statistics and the Price Section of the War Industries Board, and as the latter organization has published considerable material regarding production and trade in individual commodities. With the foreign countries the situation is quite different. In the case of England and France a fairly large amount of material of a price and trade nature has been obtained. Even so, it has been necessary to apply to the foreign consuls for additional information. Price statistics and production estimates for highly fabricated commodities have had to be obtained direct from the industries concerned. Material available here regarding England and France is legion as compared with that for Italy. Although there is not much original Japanese price material here, official statistics showing the comparative importance of different industries and a good deal of expert advice regarding commodities can be obtained. On the whole, the construction of index numbers seems an entirely feasible undertaking for the countries so far studied, and probably will be in the case of Germany, Sweden, and Spain as well. It is, however, a tedious matter and will probably require a long time for completion.

KATHARINE SNODGRASS.

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RESULTS OF TWO YEARS' OPERATION OF THE LITERACY TEST FOR ADMISSION OF IMMIGRANTS

The illiteracy test clause of the Burnett-Smith Immigration Act of February 5, 1917, went into effect on May 5, 1917. Under the provisions of this act, all aliens over sixteen years of age, physically capable of reading who cannot read the English language or some other language or dialect, are excluded from admission to the United States. The main exceptions to this clause are: (1) that any alien admitted into this country, before or after the passage of this act, may bring in or send for his father or grandfather over fifty-five years of age, his wife, his mother, his grandmother, or his unmarried or widowed daughter, whether such relatives can read or not, and (2) that aliens who cannot read but who are seeking admission into the United States to avoid religious persecution in the country of their last permanent residence may be admitted.

The following table shows the results of the operation of the illiteracy test clause during the two fiscal years ending June 30, 1918 and 1919.

It will be seen that for some races, such as the Bohemian and Moravian, the Slovak, the Magyar, the Turkish, and the Croation and Slovenian, the total number admitted during the two years is small and that consequently percentages based upon these numbers are not so significant as are those based upon the larger totals of the other races.

The total number of all races debarred in the two years on account of illiteracy was 3,053, or 426 more than shown in the table. Of the 426 not included in the table, 302 were black Africans.

During the two years of the operation of the literacy test, 205,988 aliens were admitted to this country. The number debarred on account of illiteracy was 2,627, or 1.3 per cent of the total number admitted. Excluding the Mexicans, the percentages of all races debarred on account of illiteracy were 1.1 for the two-year period, and 1.2 and .9 for the years 1917–18 and 1918–19 respectively. From the spring of 1917 to June 30, 1919, 29,563 illiterate Mexican laborers were temporarily admitted to the United States under departmental exemptions. The percentages of Mexicans debarred do not, therefore, indicate the extent to which illiterates of this race applied for admission to this country during the two years covered.*

It will be seen that among the eleven racial groups having a smaller percentage debarred than the average for all races during the two years, four represent the new immigration, namely, the Finnish, the Spanish, the Portuguese, and the Hebrews. Of the races showing proportions debarred above 1.1 per cent, the French is the only one from northwestern Europe; while all the others (Mexicans excepted) are from southern and southwestern Europe. The races showing the highest percentages debarred on account of illiteracy are the Lithuanian, the Polish, the Bulgarian, Servian, and Montenegrin, and the Syrian. The Turkish shows the highest percentages debarred during the two years; however, it should be observed that this percentage is based upon a small number admitted. It is interesting to note that of the races showing the highest proportions debarred for the two years, the Polish, the Bulgarian, Servian and Montenegrin, and the Syrian show smaller percentages debarred on account of illiteracy in 1918–19 than in 1917–18. Of the Polish, for instance, 13.4 per cent were debarred on account of illiteracy in 1917–18; while in 1918–19 only 5.2 per cent were debarred for the same cause. The proportion debarred for all races (not including Mexicans) was 25 per cent lower in 1918–19 than in 1917–18, the difference between nine-tenths of 1 per cent (0.9) and 1.2 per cent. Of the twenty-eight racial groups included in the table, fifteen show a decrease in the percentages debarred on account of illiteracy in 1918–19 as compared with 1917–18, nine show an increase, while four show no change. The two years' experience thus suggests the probability that the percentages debarred on account of illiteracy are likely further to decrease rather than to increase.

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* Report of the Commissioner-General of Immigration, 1919, pp. 24–25.

ILLITERATE ALIENS DEBARRED FROM ENTERING THE UNITED STATES DURING THE FISCAL YEARS 1917–18 AND 1918–19 COMPARED WITH THE PROPORTIONS OF ILLITERATES ADMITTED INTO THE UNITED STATES DURING THE PERIOD 1899–1917, BY RACES

Races	Total Admitted 1917–18 and 1918–19	Debarred Because Unable to Read (Persons 16 Years of Age and Over)				Per Cent Illiterates of Total Admitted 1899–1917[1]
		1917–18 and 1918–19		Per Cent of Total Admitted		
		Number	P. C.	1917–18	1918–19	
All Races[2]	205,988	2,627	1.1	1.2	.9	21.9
Welsh	886	...	....	....	....	1.1
Finnish	2,835	3	(a)	.1	.1	1.0
Norwegians, Danes and Swedes	17,002	3	(a)	....	(a)	.3
English	39,869	83	.2	.3	.2	.7
Scotch	15,568	29	.2	.2	.1	.4
Dutch and Flemish	4,935	20	.4	.5	.6	2.6
Spanish	12,133	44	.4	.4	.3	13.8
Irish	12,567	69	.5	.6	.5	1.9
Portuguese	3,893	24	.6	.6	.6	50.5
German	3,829	28	.7	.4	1.0	4.2
Hebrew	6,727	60	.9	1.0	.8	18.4
Armenian	503	6	1.2	2.2	.4	20.5
Italian, North	2,310	36	1.6	1.4	1.6	8.8
Slovak	120	2	1.7	2.8	1.2	20.0
Greek	3,415	60	1.8	1.5	2.5	23.3
Mexicans[3]	46,446	949	2.0	2.2	1.9	36.9
Bohemian and Moravian	179	4	2.2	2.7	1.9	1.2
French	19,438	571	2.9	2.9	2.9	5.9
Italian, South	7,371	217	2.9	2.6	3.5	45.3
Magyar	84	3	3.6	3.1	3.8	9.7
Roumanian	244	11	4.5	2.5	7.9	33.1
Russian	3,045	154	5.1	5.6	4.5	34.2
Croatian and Slovenian	56	3	5.4	6.0	4.3	31.1
Lithuanian	295	27	9.1	7.4	10.6	45.4
Polish	1,400	128	9.1	13.4	5.2	31.2
Bulgarian, Servian and Montenegrin	355	36	10.1	16.0	5.8	36.2
Syrian	441	49	11.1	19.0	3.9	43.4
Turkish	42	8	19.0	4.1	38.9	57.9

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[1] Illiterates during 1899–1917 are immigrants, both sexes, fourteen years of age and over, who can neither read nor write. The percentages are of the total number admitted, not of the total number admitted who were fourteen years of age and over. If the latter percentages were calculated, they would obviously be higher, but not much so because of the fact that comparatively few of the immigrants are below the age of fourteen upon their arrival.

[2] The percentages debarred for all races do not include Mexicans.

[3] Since the spring of 1917, 29,563 Mexican laborers were admitted to the United States who were exempted from the literacy test. See Report of Commissioner-General of Immigration to the Secretary of Labor, 1919, p. 25.

(a) Less than one-tenth of 1 per cent.

During the period 1899–1917, 13,821,126 immigrants from the races shown in the table were admitted into the United States. Of this number 3,029,752, or 21.9 per cent were illiterates who could neither read nor write. It goes without saying that the illiteracy clause above referred to did not reduce the proportions of illiteracy among the several races studied. It is evident that the effect of this clause has been to reduce considerably the numbers of illiterates seeking admission into this country. The Portuguese and the South Italians furnish a striking example of this. Over 50 per cent of the Portuguese admitted during 1899–1917 were illiterates; while during the two years studied only .6 per cent were excluded from admission on account of illiteracy. Of the South Italians 2.9 per cent were refused admission on account of illiteracy during 1917–18 and 1918–19, whereas during 1899–1917 over 45 per cent of the total admitted of this race could neither read nor write. The Polish, the Bulgarian, Servian, and Montenegrin, and the Syrian do not show the same reductions in the proportions of illiterates seeking admission as are shown by any of the other races exhibited in the table.

It will be noticed that the Bohemian and Moravian is the only race which shows a proportion of illiterates debarred during 1917–18 to 1918–19 which is higher than the proportion of illiterates admitted during 1899–1917. However, it should not be overlooked in this connection that the percentage of the Bohemian and Moravian debarred during this period is based on the small number admitted.

An examination of the figures in Table XVII of the Reports of the Commissioner-General of Immigration for 1918 and 1919 shows that illiteracy as a cause for exclusion from admission during the two-year period was next in importance only to the cause "likely to become a public charge." The number rejected for illiteracy was about 19 per cent of the total number debarred for all other thirty-four causes mentioned in the Reports of the Commissioner-General of Immigration.

An analysis of the data presented in the table leads to the following conclusions in regard to the effect of the operation of the illiteracy test during the first two years: (1) It has considerably reduced the proportions of illiterates seeking admission into this country, though not to the same extent among all races; (2) the proportions debarred on account of illiteracy are likely further to decrease rather than to increase; and (3) illiteracy, compared with other causes for exclusion from admission, is very important.

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STATISTICS OF COLLEGE GRADUATES

The following paper gives the results of a study of American statistics of collegiate and professional education with two objects in view: first, to estimate the number of male college graduates in the country at various dates holding degrees of A.B., B.S., Ph.B., or B.L., and the proportion of males over twenty-two years of age who held such a degree; and secondly, to estimate the number of graduates in the country at various dates holding degrees of law, medicine, or theology and to compare them with the reported number of lawyers, doctors, and clergymen.

The best source of information regarding the number of degrees of various sorts conferred each year in the United States is the annual reports* of the United States commissioner of education. From these reports my material is taken.

The problem of determining the number of men living at any particular date holding an A.B., B.S., Ph.B., or B.L. degree divides itself into two parts: first, how many men have received such degrees, and secondly, how many of them survived to a specified date. The reports of the commissioner of education contain figures for the annual number of male graduates only for the years 1880 to 1914 inclusive. The figures for years subsequent to 1914, though given, were classified differently from those of the preceding years, and in consequence it seemed best to make estimates for these years. The rate of increase of the five-year-period 1915 to 1919 over that of 1910 to 1914 was assumed to be the same as the rate of increase for the period 1910 to 1914 over that of 1905 to 1909. Applying this percentage to the figure for 1910 to 1914 gave the estimated figure for the period 1915 to 1919.

In order to obtain a basis for estimating the number of graduates in each year prior to 1880 the following test was made: figures were estimated for the years 1890 to 1900 by working backward from 1900, using both the arithmetic and geometric rate of increase for 1900 to 1910. Table I clearly shows that the geometric rate gives the better approximation to the facts.

TABLE I

ESTIMATED AND ACTUAL NUMBER OF GRADUATES 1891–1900

Year	Reported Number Graduating	Estimated Number Graduating Based on			
		Arithmetic Rate of Increase as of 1900 to 1910	Per cent Deviation	Geometric Rate of Increase as of 1900 to 1910	Per cent Deviation
1900	8,003	8,266	3.29	8,338	4.19
1899	7,764	7,734	.38	7,900	1.75
1898	7,305	7,202	1.41	7,486	2.48
1897	7,051	6,670	5.40	7,093	.60
1896	6,831	6,138	10.15	6,720	1.62
1895	6,376	5,606	12.07	6,367	.14
1894	5,803	5,074	12.56	6,036	4.01
1893	5,793	4,542	21.61	5,719	1.28
1892	5,514	4,010	27.26	5,419	1.72
1891	5,273	3,478	34.04	5,125	2.81
Average percent deviation			12.82		2.06

A further study of the reported figures for the years 1880 to 1910 reveals the fact that the rate of increase is itself increasing. Thus the rates of decennial increase 1880 to 1890, 1890 to 1900, and 1900 to 1910 were 3¼ per cent, 4½ per cent and 5¼ per cent respectively. In view of this fact the rate for the ten years 1880 to 1890 seemed the best to apply to years prior to 1880, and the figures used are based upon this 3¼ per cent rate.

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* In respect to the trustworthiness and completeness of his figures, the present commissioner of education in a letter to the writer says that in his opinion they are as trustworthy as could be obtained, and that "the institutions which failed to report to this office would probably not average more than ten, and they would represent as a rule the smaller institutions."

In order to estimate the number of graduates living at any particular date as shown in Tables V, VI, VII and VIII, the life table* for males in the original registration area for 1909 to 1911 was used. It was assumed that the average age of graduation is twenty-two years, and thus the 77,974 men shown by that life table as living at that age were considered as the base, or 100 per cent. By dividing the number living at each succeeding year by this number, percentages are obtained showing the proportion of these 77,974 men who would be living at each succeeding year of age. Applying these percentages to the number of graduates for the various years gives the number living at each year of life.

The fact of especial significance brought out by the figures in the first column of Table V is the rapidly increasing number of graduates turned out annually by our colleges and universities. More than half of the 496,618 degrees granted since 1815 have been conferred since 1900, and of the 358,026 male college graduates living June 1, 1920, over half received their degrees after 1905. Thus the majority of the college trained men of today are under 37 years of age, and have not yet reached the full fruition of their power and training. Though the last decade has witnessed the most marked increase in the annual number of graduates of our colleges and universities, yet this same tendency is noticeable throughout each period for which figures are obtainable. The number of male college graduates per 100,000 males over twenty years of age for the last five census dates are as follows:

TABLE II

RATIO OF COLLEGE GRADUATES TO POPULATION

Census Date	Living Male College Graduates per 100,000 Males Over 20 Years of Age
1880	687
1890	710
1900	745
1910	874
*1920	1137

* It is assumed that the increase of the male population over twenty years of age for the decade 1910 to 1920 was by the same amount as that for the decade 1900 to 1910.

In studying the professional degrees granted by universities and professional schools, the same general method of analysis was followed. Tables VI, VII and VIII show by five year periods the results of these computations for graduates in law, medicine, and theology. From 1815 through 1919 our law schools have graduated 138,603 men, our medical schools 236,318, and our theological schools 80,951. The most striking fact shown by these figures is the rapidly decreasing number of medical graduates. The estimated number of degrees granted by medical schools in the period 1915 to 1919 was less than in any previous quinquennial period subsequent to the period 1875–1880. Since the year 1904, when 5,702 received medical degrees, there has been an almost steady falling off in the number of medical graduates. The same tendency is noticeable in respect to the students in attendance, there being in 1903, 27,062 students enrolled in medical schools, while in 1915 this figure was only 15,000.

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* Bureau of Census of United States Life Tables: 1910, pp. 18 *et seq.*

Among the reasons for this decrease as stated by the commissioner of education in his report of 1909 are: (1) The increased rigor of state and college requirements; (2) the adoption of the four year course by most schools; and (3) much severer college entrance requirements. Modern medical education is becoming more costly because of the time that must be spent in training and because of the actual money outlay. Expensive laboratories must be established and maintained and abundant hospital facilities provided.

A second striking fact to be derived from these statistics is the rapidly increasing ratio of college trained physicians to total practitioners given by the census. The number of physicians holding a medical degree per 1,000 practising physicians for the census dates 1880, 1890, 1900, and 1910 has been 591, 757, 885, and 952 respectively. Though the ratio of total physicians per 100,000 population has remained about the same during this period, being for these dates 171, 167, 174, and 172 respectively, that for physicians with a degree from a medical college has shown a steady increase, being for the same dates 101, 126, 153, and 163 respectively. We have relatively no more physicians today than we had a generation ago, yet the figures indicate that those we do have are better trained than those who attended our parents.

This same tendency is shown in regard to lawyers and clergymen although to a less marked degree, as the following table indicates:

TABLE III

RATIO OF COLLEGE-TRAINED TO TOTAL LAWYERS AND CLERGYMEN

Year	Practitioners With a Professional Degree per 1,000 Total Practitioners	
	Lawyers	Clergymen
1880	294	256
1890	286	263
1900	400	312
1910	595	423

The number of lawyers and clergymen per 100,000 population is shown by the following table:

TABLE IV

RATIO OF LAWYERS AND CLERGYMEN TO POPULATION

Year	Total Practitioners		College-Trained Practitioners	
	Lawyers	Clergymen	Lawyers	Clergymen
1880	128	129	38	33
1890	143	140	40	36
1900	151	147	60	45
1910	133	163	79	49

Probably the main reason for the increasing proportion of medical and legal students who receive their training in universities and professional schools lies in the increasing rigor of state examinations. This is particularly true in the medical profession where great strides have been made in the last generation along the line of state supervision. In the report of 1880 the commissioner of education wrote, speaking of the medical profession: "The profession has been overcrowded for many years chiefly because of the scandalous ease with which men imperfectly educated or not educated at all have been able to assume its titles and duties."

TABLE V

MEN HOLDING AN A.B., B.S., PH.B., OR B.L. DEGREE

Year	Number Graduating	Those Living on June First				
		1920	1910	1900	1890	1880
*1915–19	95,159	93,611				
1910–14	71,515	68,249				
1905–09	54,190	49,805	53,290			
1900–04	45,172	39,598	43,117			
1895–99	35,327	29,253	32,461	34,743		
1890–94	27,411	21,154	24,015	26,154		
1885–89	26,157	18,429	21,643	24,023	25,663	
1880–84	23,293	14,457	17,971	19,911	22,223	
*1875–79	19,567	10,118	13,794	16,196	17,970	19,240
1870–74	16,797	6,706	10,421	12,957	14,717	16,025
1865–69	14,417	4,045	7,456	10,165	11,933	13,245
1860–64	12,373	1,924	4,938	7,677	9,545	10,840
1855–59	10,820	677	2,907	5,491	7,487	8,791
1850–54	9,110		1,417	3,637	5,651	7,022
1845–49	7,813		527	2,139	4,039	5,508
1840–44	6,703			1,002	2,675	4,159
1835–39	5,750			390	1,573	2,973
1830–34	4,925				765	1,967
1825–29	3,380				285	1,156
1820–24	3,627					564
1815–19	3,112					211
Total	496,618	358,026	233,957	164,485	124,526	91,701

* Figures for the number of graduates prior to 1880 and for the period 1915–19 are estimates.

In addition to the increasing rigor of state bar examinations many students are undoubtedly being sent to law schools through their inability to secure adequate legal training in the offices of practitioning attorneys. Regarding this the late Chief Justice Waite said: "The time has gone by when an eminent lawyer, in full practice, can take a class of students into his office and become their teacher. Once that was practicable, but now it is not. The consequence is that the law schools are now a necessity."

An interesting relationship seems to exist between the law and medical graduates. Since 1904 the annual increase in the number of law graduates roughly equals the annual decrease in the number of medical graduates. In 1910 there were 5,555 fewer medical students than in 1904, while there were 5,261 more law students. This relationship is quite natural, for while medical college requirements are becoming increasingly difficult, law college requirements show the opposite tendency. Thus in 1880, in order to enroll in the Columbia Law School one had to pass examinations in Roman, English, and United States his-

TABLE VI

PERSONS HOLDING DEGREES CONFERRED BY LAW SCHOOLS

Year	Number Graduating	Those Living on June First				
		1920	1910	1900	1890	1880
*1915–19	24,031	23,632				
1910–14	21,451	20,464				
1905–09	17,985	16,524	17,686			
1900–04	16,851	14,756	16,072			
1895–99	14,919	12,350	13,705	14,669		
1890–94	9,981	7,724	8,765	9,536		
1885–89	5,080	3,597	4,217	4,674	5,001	
1880–84	4,755	2,933	3,656	4,157	4,530	
*1875–79	4,646	2,408	3,279	3,849	4,272	4,569
1870–74	3,670	1,467	2,279	2,831	3,216	3,502
1865–69	3,025	829	1,566	2,133	2,505	2,779
1860–64	2,497	390	998	1,649	1,926	2,188
1855–59	2,057	140	563	1,065	1,451	1,703
1850–54	1,697	28	264	677	1,053	1,308
1845–49	1,403		95	384	725	988
1840–44	1,161		14	182	464	872
1835–39	961			65	264	497
1830–34	795				124	317
1825–29	655				45	178
1820–24	540					85
1815–19	443					29
Total	138,603	107,251	73,159	45,871	25,576	18,864

* Figures for the number of graduates prior to 1880 and for the period 1915–19 are estimates.

TABLE VII

PERSONS HOLDING DEGREES CONFERRED BY MEDICAL SCHOOLS

Year	Number Graduating	Those Living on June First				
		1920	1910	1900	1890	1880
*1915–19	16,855	16,558				
1910–14	20,165	19,252				
1905–09	25,013	22,945	24,572			
1900–04	27,073	23,718	25,825			
1895–99	25,846	21,388	23,735	25,411		
1890–94	23,323	17,982	20,427	22,245		
1885–89	19,987	14,095	16,543	18,358	19,647	
1880–84	16,966	10,521	13,085	14,862	16,185	
*1875–79	13,655	7,080	9,640	11,314	12,550	13,433
1870–74	10,431	4,172	6,478	8,051	9,142	9,952
1865–69	8,283	2,275	4,289	5,843	6,863	7,612
1860–64	6,581	1,028	2,631	4,088	5,078	5,768
1855–59	5,225	355	1,435	2,706	3,686	4,328
1850–54	4,149	87	649	1,659	2,577	3,202
1845–49	3,292		224	905	1,704	2,322
1840–44	2,613		50	409	1,046	1,622
1835–39	2,075			141	571	1,075
1830–34	1,644			28	256	657
1825–29	1,302				96	358
1820–24	1,033					162
1815–19	816					56
Total	236,318	161,456	149,583	115,020	79,401	50,547

* Figures for the number of graduates prior to 1880 and for the period 1915–19 are estimates.

TABLE VIII

PERSONS HOLDING DEGREES CONFERRED BY THEOLOGICAL SCHOOLS

Year	Number Graduating	Those Living on June First				
		1920	1910	1900	1890	1880
*1915–19	10,175	10,007				
1910–14	9,440	9,004				
1905–09	8,147	7,485	8,009			
1900–04	8,179	7,159	7,799			
1895–99	8,338	6,900	7,658	8,198		
1890–94	7,030	5,423	6,159	6,706		
1885–89	5,113	3,619	4,242	4,704	5,032	
1880–84	3,737	2,317	2,883	3,272	3,565	
*1785–79	3,784	1,950	2,663	3,127	3,472	3,719
1870–74	3,465	1,384	2,151	2,673	3,036	3,306
1865–69	2,815	772	1,456	1,985	2,331	2,586
1860–64	2,289	357	915	1,421	1,765	2,005
1855–59	1,864	126	510	964	1,314	1,544
1850–54	1,518	25	237	607	943	1,171
1845–49	1,236		89	337	640	872
1840–44	1,006			158	401	623
1835–39	816			56	223	423
1830–34	663				105	264
1825–29	538				36	146
1820–24	438					68
1815–19	360					25
Total	80,951	56,528	44,771	34,208	22,863	16,752

* Figures for the number of graduates prior to 1880 and for the period 1915–19 are estimates.

tory, Greek, Latin, and Rhetoric. Compare these requirements with the following quotation from the 1910 report of the commissioner of education: "In the 114 legal institutions with the exception of the law departments of about one dozen universities admission is readily granted to graduates of high schools. About one-quarter of the law schools allow graduation after two years of attendance and two schools grant degrees after only one year of attendance."

One cannot but be impressed in studying these figures by the increasing importance of the college-trained man in the professions. More and more he is becoming the dominating figure among professional men. In 1880, 59 per cent of our physicians held a medical degree, while in 1910, 95 per cent of them had received this degree. Apparently our health is better attended to than either our property or spiritual welfare, yet these last two professions show the same increasing dominance of the college-trained man.

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THE BEST INDEX OF BUILD

Robustness is a rough index of health. Since the weight of men varies with their height, the mere weight is of little use as an index of robustness, and just how robustness may be best expressed quantitatively is a matter of doubt. The naive procedure is to divide the weight by the height; but this has the serious objection that while height is a linear dimension, weight is really a volumetric dimension. Were men approximately cylinders of different height, then the weight divided by the height would give an appropriate index of build; but obviously the hypothesis is not in accordance with the facts. It has sometimes been urged that since bodies of the same shape but of different size vary in volume as the cube of any diameter, that weight should be divided by the cube of height in order to secure index of build; but the hypothesis that men of different stature are of the same form is also not justified; for tall men have a prevailingly slender build and short men are on the average stockier. Nevertheless, the method of securing a measure of build by dividing weight by the cube of the height has been extensively used and is urged by Professor C. R. Bardeen in a recent publication (Number 272) of the Carnegie Institution of Washington.

A test of the best method of measuring build may be made as follows: An extensive table of army measurements shows that the commonest stature is 67 inches, that the commonest combined units of stature and weight are the group 67 inches tall and 137 pounds in weight. The quotient for this modal class of

$$\frac{137 \text{ pounds}}{67 \text{ inches}}$$

is, in the case of the first power of 67, 2.045; for one hundred times the quotient obtained by using the second power as a divisor, 3.052, and for 10,000 times the quotient obtained by using the third power of 67 as a divisor, 4.555. By taking now a series of combinations of weight and height in each of which there is found at least 1 per cent of men as measured in the army draft, we secure a series of fractions in which the numerator is the weight in pounds and the denominator the height in inches. The selected measures are:

$$\frac{117}{63}, \frac{127}{63}, \frac{117}{65}, \frac{127}{65}, \frac{137}{65}, \frac{117}{67}, \frac{127}{67}, \frac{147}{67}, \frac{157}{67}, \frac{127}{69}, \frac{137}{69}, \frac{147}{69}, \frac{157}{69}, \frac{147}{71}, \frac{157}{71}, \frac{167}{71}.$$

These relations were worked out by using the weight in pounds as the dividend and by using as a divisor in turn the first power, the second power, and the third power of the height in inches. From each of the quotients in which the first power of the height was used as a divisor there was obtained the deviation from 2.047; the deviation from 3.052 was obtained from each of the quotients when the second power was used as a divisor; and the deviation from 4.555 when the third power of the height was used as a divisor. The sum of the deviations disregarding signs was, when the first power was used as a divisor, 2.587. Divided by the reference standard of 2.045, this gives 1.265, which is the *relative* variability of the sixteen group combinations as obtained by using the first power of the height as a divisor. By using the second power of the height as a divisor, the corresponding figure is 1.146; by using the third power as a divisor, it is 1.237. Hence, the outlying groups give the smallest deviation from the condition found in the central group when the second power of the height is used as a divisor.

In still another way can we show that by using the second power of height as a divisor better results are obtained than by using the first or the third power. As is well known, shorter men are on the average more robust than tall men. By calculating the ratios for shorter and taller men of the same average weight with the use of the first, second, and third powers of height respectively, we secure the results indicated in Table I.

TABLE I

SHOWING (A) THE WEIGHT AND HEIGHT FOR WHICH THE WEIGHT-HEIGHT INDEX IS CALCULATED; (B) THE CORRESPONDING INDEX WHEN THE FIRST POWER OF HEIGHT IS USED; (C) THE CORRESPONDING INDEX WHEN THE SECOND POWER OF HEIGHT IS USED; (D) THE CORRESPONDING INDEX WHEN THE THIRD POWER OF HEIGHT IS USED

(A)			(B)			(C)			(D)		
$\frac{117}{61}$	$\frac{117}{66}$	$\frac{117}{70}$	1.92	1.77	1.67	3.14	2.69	2.39	5.16	4.07	3.41
$\frac{127}{62}$	$\frac{127}{67}$	$\frac{127}{71}$	2.05	1.90	1.79	3.30	2.30	2.52	5.33	4.22	3.55
$\frac{137}{63}$	$\frac{137}{68}$	$\frac{137}{72}$	2.18	2.01	1.90	3.45	2.96	2.64	5.48	4.36	3.67
$\frac{147}{64}$	$\frac{147}{69}$	$\frac{147}{73}$	2.30	2.13	2.01	3.59	3.09	2.76	5.60	4.47	3.78
$\frac{157}{64}$	$\frac{157}{69}$	$\frac{157}{73}$	2.45	2.28	2.15	3.83	3.3	2.95	5.99	4.79	4.04
$\frac{167}{65}$	$\frac{167}{70}$	$\frac{167}{74}$	2.57	2.39	2.26	3.95	3.41	3.05	6.08	4.87	4.12

From this table it appears that when the first power of height is used in the ratio, the increase in robustness of abmodally short men over abmodally tall men is about 10 per cent; with the second power it is about 30 per cent; with the third power it is about 50 per cent. It is quite clear that the shorter men are not 50 per cent more robust on the average than the tall men, though opinion may be divided as to whether a 30 per cent or a 10 per cent increase more nearly agrees with the general impression obtained by observing a number of men 4 inches above the mean as compared with the number of men measuring 5 inches below the mean stature.

In still another respect does the use of the square of the height in determining the build show its superiority as a measure over the first and second power of height. Thus if we start with the data given in Bardeen's Table E, which in turn is based on one of Quetelet's (1870), we may compare the coefficients of build for different years of development from one to thirty, and we may compare the coefficients of build as obtained by calculating the ratio of weight to the first power of height, to the second power of height, and to the third power of height, respectively, for each year. We then select some median age at a point of departure and for this purpose we select twelve years. We then find the deviations of the respective ratios from the twelve-year ratio and divide the average deviation by the first year ratio in order to secure a coefficient referred to the appropriate standard. In consequence of the suggestion made by Quetelet, it is worth while to calculate also the ratio of weight to the $2\frac{1}{2}$ power of height and to find the corresponding coefficient.

The suggested calculations have been made and are given in Table II. The first column gives the age in years of the group measured, the second column

TABLE II

DEVIATIONS OF WEIGHT-HEIGHT INDEXES FROM 12 YEAR RATIO

	$\frac{\text{Weight}}{\text{Height}}$	$\frac{\text{Weight}}{\text{Height}\,(^{2})}$	$\frac{\text{Weight}}{\text{Height}\,(^{3})}$	$\frac{\text{Weight}}{\text{Height}\,(^{2\frac{1}{2}})}$
12 year ratio...........	210.909	1.5339	.1116	.13081
Birth..................	148.909	.2939	.1364	.04455
1 yr..................	82.024	.3134	.1530	.09030
2 yr..................	71.845	.2242	.1107	.06686
3 yr..................	66.233	.1405	.0822	.04934
4 yr..................	59.885	.0952	.0641	.03840
5 yr..................	49.815	.0983	.0538	.03348
6 yr..................	40.737	.0930	.0439	.02826
7 yr..................	32.567	.0724	.0348	.02362
8 yr..................	25.023	.0659	.0261	.01756
9 yr..................	17.970	.0502	.0185	.01272
10 yr..................	12.952	.0212	.0106	.00702
11 yr..................	6.137	.0040	.0045	.00279
12 yr..................				
13 yr..................	21.698	.1007	.0033	.00622
14 yr..................	31.643	.1853	.0054	.01110
15 yr..................	61.398	.2659	.0074	.01551
16 yr..................	81.240	.3461	.0094	.02000
17 yr..................	100.885	.4222	.0111	.02412
18 yr..................	119.766	.4948	.0129	.02809
19 yr..................	137.127	.5691	.0155	.03266
20 yr..................	145.378	.5996	.0162	.03428
25 yr..................	182.670	.8061	.0175	.04961
30 yr..................	181.143	.7914	.0263	.04827
Total deviation.........	1677.035	6.0534	.8636	.68476
Average deviation.......	76.229	.2752	.03925	.031125
Average deviation divided by 12 year ratio.......	.3614	.1794	.3517	.2379

gives the ratio of weight to the first power of height, and the succeeding columns the ratios of weight to the second, third, and 2½ powers of height respectively. The ratio for twelve-year old persons is given in the first line, and in the subsequent lines are given the deviations from the twelve-year old ratio. At the bottom is given the average deviation for all the ages from the twelve-year old ratio, and in the line below that, the relative deviation as obtained by dividing the average deviation by the twelve-year old ratio. One sees that in the relative average deviations the worst result is given by the use of the first power of the height, the next poorest by using the third power, the next by using the 2½ power. The smallest average deviation from the assumed standard is given by dividing weight by the second power of the height.

From these different tests, therefore, we draw the conclusion that the best index of build is the weight divided by the square of the height. The theoretical justification for this lies in the fact that since men do not vary in volume by the first power of height like cylinders of the same diameter, nor like spheres by the cubes of height, but in a manner intermediate between the two, so that we may expect to find the appropriate divisor for the index of build not the first power or the third power, but some intermediate power, and apparently the second power of height shows its superiority to either of the others and even to the 2½ power. It is on this account that the best single index of build is secured by dividing weight by the square of stature.

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FAMILY STATISTICS IN NEW ZEALAND

Certain data in regard to families are normally secured in all countries. The information regarding the origin of families is contained in marriage statistics; birth statistics show the progress of the increase in size of families, and the breaking up of families is shown by the statistics of divorces and by those of deaths of married persons. In census, as distinguished from registration statistics, the material presented usually includes marital or civil condition of population and frequently the number and size of families or households.

New Zealand, for many years, has published as part of her registration statistics, tables showing the number of widows and orphans left by the breaking up of families by death, in correlation with the ages of the fathers. The original data were secured by an additional question put on the death certificates in which the number and ages of the surviving members of the family were secured. The value of this information in connection with nation-wide provision for dependents of soldiers killed in war can easily be understood.

This new departure in vital statistics has now been followed by a detailed analysis of families and households existing at the date of the census of 1916.* Households are divided into those inhabiting private dwellings and tenements and other households, and the first group is made the subject of special analysis. Tables are shown classifying heads of households by sex and marital condition, age, and by number of persons, number of adults, number of children under fourteen, number of breadwinners, and number of non-breadwinners in the household.

Among the population 1,099,449 found at the census of October, 1916, there was a total of 238,066 households inhabiting private dwellings and tenements. Of these households 204,373 had male and 33,693 had female heads.

Ten per cent of the heads of households had never married. About half of these were persons living alone; in only 1,861 cases, or less than 1 per cent of the total number of families, were there children under fourteen in the family. This number would doubtless include some who had been forced to assume the responsibility of caring for a family, the children of which had been orphaned and left without their natural fathers and mothers; they would perhaps include a few unmarried mothers, although many of this group might be returned as married.

The marital condition of the heads of a small number of families, 1,566, was not stated. Of 211,633 families whose heads were either married, widowed, or divorced, 182,199 were reported headed by males and 29,434 headed by females. The normal family group with father and mother living would be included, in the main, in the group with male heads.

In the consideration of those families in which the head was a male, a point of some interest is distribution by number of breadwinners. A small number, 729, were reported as having no breadwinner. The great majority, or 56.8 per cent, had only one breadwinner each; nearly one-fourth reported two breadwinners each, and one-tenth reported three breadwinners each. The average number of breadwinners per family headed by males in this group was 1.7.

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* Results of a census of the Dominion of New Zealand taken for the night of the 15th October, 1916, Part XII, Households, Malcolm Frazer, Government Statistician, Wellington, by authority Marcus F. Marks, Government Printer, 1918.

The average number of non-breadwinners in families headed by male heads is found to be 2.9. The tables also give separately by cities and the rest of the Dominion the relative proportions in the family between the breadwinners and the non-breadwinners.

In regard to the number of children under fourteen living in these families, it appears that slightly over one-third of these families had no children living with them; somewhat over one-fifth had one child each; one-sixth had two children each; nearly one-eighth had three children each; not quite one-twelfth had four children each; and not quite one-twelfth had more than four children each. Among the entire group the average number of children per family was 1.6. In families which had one or more children, the average number of children was 2.4. Of course these figures do not represent the number of children which these families would ultimately have, since in the families in the group taken are included the newly established families as well as those that have lasted for many years. The figures present rather a picture of the distribution of families according to the number of children at a given time.

Besides the families headed by males, there were 29,434 families whose heads were married, widowed, or divorced females. On an average, in these families there were 1.1 children per family with a female head. Slightly over half, however, reported no children at all. For families in which children were reported living, there were 2.3 children on an average. It appears on comparison with similar families headed by males, that the average number of children is somewhat less in this group than in the other group.

Over half, or 57 per cent, of the group reported themselves widows. Two-thirds of this number reported no children living with them, and among the remainder the average number of children living with them was 2.0. It appears, then, that the average number of children living with widows is somewhat less than the number of children living in a normal family headed by a married man. The average age of the widows was about sixty-one years.

The group includes, besides the widows and the divorced, 12,316 females who reported themselves as married. The significance of this group is a little doubtful since the ordinary family, with both husband and wife living, would be reported as with a male head. On analysis, it appears that in nearly half of these families the head of the household was the only adult. The average age of these married females, heads of families, appears to be considerably lower than the average age of widows. Probably the great majority were wives of soldiers away at the front.

Other groupings are also made of the data. Heads of households are classified by economic status, whether employer or working for wages. The wage-earning group, including those unemployed, amounted to 112,000, while the group of employers and those in business or working on their own account, included 84,000 or four-fifths as many.

Heads of households are also classified by home ownership. In the entire group, 112,000 were owners of freeholds—about half unencumbered and about half mortgaged. About 12,000 more were buying their homes on time payments. Ninety-nine thousand were renting their homes. In 15,000 cases this information was not reported.

The proportion of wage-earners who were renting their homes was much higher, 53 per cent, than the proportion of employers who were renting, only 25 per cent. Of persons in business or working on their own account, not employing others, a slightly larger proportion (30 per cent) than of employers, were renting their homes.

Other tables show the economic status in relation to the renting value of the home and the size of the household in connection with home ownership.

It is to be regretted that the tables are published without critical and analytical text. The material would be very much more useful if the statistical definitions of units and cautions in regard to the interpretation of the figures were given. It should be mentioned, however, that summaries of the principal statistical results of census as well as registration statistics are published in the official year books.

Robert M. Woodbury.

FEDERAL RESERVE BOARD'S INDEXES ON CONDITION OF RETAIL TRADE

It has long been recognized that the condition of retail trade constitutes a valuable indication of the probable changes in business weather. Nevertheless, it has been the custom in current trade periodicals for the situation in retail trade to be reported in highly subjective and descriptive terms, that is to say, by such words as poor, fair, good, very good, etc. It was for the purpose of rendering current reports of the condition of retail trade in as objective terms as possible that the Division of Analysis and Research of the Federal Reserve Board undertook, through the Federal Reserve agent's department of each of the Federal Reserve banks, to compile and publish monthly statistics designed to reflect the condition of retail trade throughout this country. For this purpose the large department stores in the more important cities throughout the United States were chosen as a source of information. The data compiled each month are as follows:

1. (A) Net sales (selling price) for current month as compared with same month last year.

(B) Net sales (selling price) for current season to date (seasons begin January 1st and July 1st) as compared with similar period the previous year.

2. (A) Stocks (selling price) on hand at end of current month as compared with stocks at end of same month last year.

(B) Stocks (selling price) on hand at end of current month as compared with stocks on hand at end of previous month.

3. Ratio between average stocks on hand at end of each month during the current season (seasons begin January 1st and July 1st) and net sales for the same period.

4. Percentage of outstanding orders (cost price) at end of current month to total purchase (cost price) during the previous calendar year. This ratio is designed to

reflect the extent to which merchants are ordering goods for the coming months and the extent to which they are holding back for more favorable prices or conditions.

In some of the Federal Reserve districts this information is obtained from all of the stores in dollar amounts, from which the agents compute the district and city percentages and ratios. In other districts some of the stores prefer to furnish the information in the form of percentages, that is to say, for instance, the percentage increase (or decrease) in net sales during the current month over net sales during the same month the previous year. When all of the stores reporting in any district give the information in dollar amounts, the preparation of composite or average figures for that district is, of course, relatively simple. Where, however, the stores prefer to furnish the data in percentage form, the problem of proper weights to be used in making composite figures by cities or for the district arises. The weights now being used for this purpose are derived from net sales for the previous calendar year.

Composite figures by cities (where sufficient stores are reporting in a city to render it impossible for any one to deduce figures for the individual store) and for the district are computed by the Federal Reserve agent as soon as all of the reports are in. These average or composite figures are immediately forwarded to contributing stores. The data for each Federal Reserve District also appear in the published report of the Federal Reserve Bank on business conditions, which comes from the press about the twenty-fifth of each month. The reports from each of the districts are assembled and published in the *Federal Reserve Bulletin* showing the state of retail trade throughout the whole country. This service is rapidly gaining the confidence and interest of large retail trade merchants throughout the country. At present about one hundred and fifty stores are reporting each month. It is thought that in the comparatively near future at least two hundred stores will be reporting regularly.

Although encouraging progress has been made, the service is yet in process of being built up. Ten or fifteen new stores are added to the reporting list each month. For this reason caution should be observed in interpreting the figures over a period of time, though, of course, comparisons are made between identical stores in any given month. It is interesting, however, to note the reflection, in the accompanying table taken from the *Federal Reserve Bulletin*, of the slowing up in retail trade—which, as is well known, has been going on for several months—the effect of reduction sales in several of the centers, and consequent upon the latter, the improvement in turnover. The figures of outstanding orders are particularly difficult to interpret at this time, due to the disturbed transportation situation. There is no doubt that in many cases, particularly a month or two ago, the outstanding orders included orders on which delivery was overdue as well as actual orders for future delivery.

It is not claimed, of course, that these figures are perfect for the purpose of reflecting the condition of retail trade. Their most serious shortcoming is the fact that they are in terms of values. This requires, of course, that the influence of fluctuating prices be eliminated by the individual's making use of the material. However, as yet no practicable method of obtaining this information in terms of

CONDITION OF RETAIL TRADE IN FEDERAL RESERVE DISTRICTS NOS. 1, 2, 3, 4, 5, 6, 7, 10, AND 12*

[Percentage of Increase]

Comparison of Net Sales with Those of Corresponding Period Previous Year

District and City	March, 1920	April, 1920	May, 1920	Jan. 1, 1920, to Close of—				
				June, 1920	March, 1920	April, 1920	May, 1920	June, 1920
District No 1:								
Boston	38.9	16.8	19.4	27.8	30.7	26.1	24.7	25.3
Outside	29.4	26.0	25.5	28.5	36.4	33.1	30.5	30.0
District	37.5	18.5	20.7	28.0	31.6	27.5	25.8	26.2
District No 2:								
New York City and Brooklyn	66.6	15.0	41.1	26.4	59.3	35.0	35.3	32.7
Outside	50.4	22.4	22.8	32.3	38.1	33.6	30.1	31.7
District	64.8	15.8	35.4	28.4	57.0	34.9	33.7	33.8
District No. 3	37.5	12.4	50.7	34.3	26.2	20.5	30.9	31.4
District No. 4	45.5	18.4	31.3	31.5	38.2	33.6	32.1	34.6
District No. 5	23.1	3.9	11.0	21.4	12.1	8.8	9.3	11.6
District No. 6	27.4	23.4	31.0	24.3	29.9	22.0	28.1	29.3
District No. 7	65.2	33.3	49.7	59.6	57.4	43.5	49.6	58.7
District No. 10	24.6	19.6	10.9	12.9	26.9	24.9	21.2	17.9
District No. 12:								
Los Angeles	58.4	43.6	38.2	39.0	61.2	56.1	52.2	49.8
San Francisco	35.4	28.5	40.9	23.6	39.7	36.6	37.6	35.3
Oakland	31.0	14.9	17.1	15.2	32.3	27.9	25.6	23.2
Sacramento	65.1	33.9	34.4	32.1	60.9	47.5	39.4	38.3
Seattle	19.2	4.3	6.3	11.1	21.8	16.2	13.9	13.4
Spokane	19.8	10.9	48.8	62.8	26.8	23.1	29.1	35.7
Salt Lake City	10.5	7.1	26.4	18.3	15.1	12.8	16.4	14.7
District	37.8	13.8	31.2	27.8	41.0	36.9	34.7	33.2

Stocks at End of Month Compared with—

District and City	Same Month Previous Year				Previous Month			
	March, 1920	April, 1920	May, 1920	June, 1920	March, 1920	April, 1920	May, 1920	June, 1920
District No. 1:								
Boston	42.3	45.2	44.5	43.8	9.9	4.0	[1]3.4	5.6
Outside	44.9	43.2	43.8	36.3	11.9	2.8	[1]1.8	5.1
District	42.8	44.7	44.3	41.4	10.2	3.7	[1]2.9	5.5
District No. 2:								
New York City and Brooklyn	69.6	53.8	47.9	45.5	27.9	[1].3	[1]6.6	5.4
Outside	60.6	51.6	51.7	38.4	9.3	[1]1.4	[1]1.7	7.7
District	68.6	53.6	49.1	43.2	25.8	[1].4	[1]5.0	6.1
District No. 3	24.3	25.7	30.4	26.7	12.3	5.4	[1]6.7	3.0
District No. 4	56.1	63.9	57.0	53.3	11.6	7.3	[1].9	1.0
District No. 5	51.5	59.5	67.1	57.2	14.1	[1].1	2.3	9.2
District No. 6	41.1	29.9	50.2	47.2	4.7	3.0	[1].5	5.6
District No. 7	64.9	39.9	49.7	77.1	10.1	....	2.1	.0
District No. 10	38.9	43.3	40.7	39.6	7.8	3.1	[1]6.1	8.8
District No. 12:								
Los Angeles	58.3	64.9	65.0	62.9	7.8	3.7	[1].5	.4
San Francisco	62.2	60.7	54.9	58.5	6.1	2.4	[1]6.5	5.2
Oakland	35.2	34.4	29.7	33.9	6.5	[1].5	[1].6	2.6
Sacramento	61.8	29.4	34.1	....	3.7	....	[1]1.5	.1
Seattle	53.8	55.5	46.7	35.6	14.9	....	[1]6.7	8.7
Spokane	63.3	39.0	59.6	57.3	27.9	[1]40.2	[1]5.7	4.4
District	58.0	56.5	52.6	52.5	9.6	....	[1]4.7	3.0

CONDITION OF RETAIL TRADE IN FEDERAL RESERVE DISTRICTS—*Continued*

District and City	Percentage of Average Stocks at End of Each Month to Average Monthly Sales for Same Period				Percentage of Outstanding Orders at End of Month to Total Purchases During Previous Calendar Year			
	Jan. 1, 1920, to End of—							
	March, 1920	April, 1920	May, 1920	June, 1920	March, 1920	April, 1920	May, 1920	June, 1920
District No. 1:								
Boston	509.5	389.8	348.4	339.2	18.8	15.8	15.4	15.4
Outside	320.5	464.7	442.5	431.7	18.6	15.5	7.5	10.0
District	389.9	405.2	366.5	358.0	18.7	15.7	12.7	12.3
District No. 2:								
New York City and Brooklyn	384.7	403.1	392.4	379.9	18.8	17.6	15.5	16.8
Outside	372.3	392.8	415.7	349.5	20.3	21.8	13.9	17.7
District	383.4	402.0	399.4	369.9	19.0	18.2	14.8	17.2
District No. 3	380.0	347.0	382.6	357.5	24.8	23.5	17.6	19.3
District No. 4	369.1	439.0	362.8	352.3	19.4	34.8	13.2	16.2
District No. 5	423.8	422.2	421.5	407.8	16.9	12.1	9.9	9.7
District No. 6	305.8	.....	.....	.....	20.9	20.1	20.6	17.0
District No. 7	298.6	332.5	.....	328.3	31.4	31.2	31.9	19.5
District No. 10	337.6	272.1	285.4	353.7	14.6	18.0	5.4	25.3
District No. 12:								
Los Angeles	468.3	390.7	480.4	481.3	33.9	39.0	29.7	26.2
San Francisco	494.9	492.3	469.8	508.8	31.0	27.7	23.9	26.0
Oakland	610.7	585.2	589.5	573.8	....	....	....	....
Sacramento	.....	.....	533.4	531.3	....	....	....	....
Seattle	542.6	527.9	539.7	524.6	17.6	17.2	14.2	16.3
Spokane	605.8	528.8	605.4	579.4	34.7	....	31.1	25.1
Salt Lake City	.....	.....	.....	.....	....	....	....	....
District	515.3	456.0	508.0	516.0	27.2	21.6	23.2	23.1

[1] Decrease.

* The Federal Reserve Districts listed above are numbered as follows: District No. 1, Boston; No. 2, New York; No. 3, Philadelphia; No. 4, Cleveland; No. 5, Richmond; No. 6, Atlanta; No. 7, Chicago; No. 10, Kansas City; and No. 12, San Francisco.

physical quantities has been devised. No attempt has been made to combine figures of the various sections of the country into one set of indexes reflecting the condition of retail trade throughout the country. It is felt that such a figure would be of doubtful value, inasmuch as the condition of retail trade in the large centers may be quite different from that in the smaller cities and rural districts. It is the purpose of the Federal Reserve Board to make every effort to build up this reporting service until it includes a representative number of retail stores throughout the country.

F. W. JONES.

DEVELOPMENTS IN THE BANKING FIELD WITH SPECIAL REFERENCE TO FEDERAL RESERVE MATTERS

In accordance with the plan adopted last year of publishing a mid-summer statistical review supplementary to the more elaborate presentation in the annual report, the July number of the *Federal Reserve Bulletin* contains a series of tables showing developments in the banking situation during the past year.

The following table shows the condition of all the banks belonging to the

Federal Reserve System on June 30, November 17, and December 31, 1919, and on May 4 and June 30, 1920, these being the dates for which reports were required from all member banks during the past year:

ABSTRACT OF REPORTS OF CONDITION OF ALL MEMBER BANKS OF THE FEDERAL RESERVE SYSTEM

[In Thousands of Dollars]

	June 30, 1919 (8,822 Banks)	Nov. 17, 1919 (8,995 Banks)	Dec. 31, 1919 (9,066 Banks)	May 4, 1920, (9,291 Banks)	June 30, 1920 (9,399 Banks)
RESOURCES					
Loans and discounts	14,890,471	16,603,963	17,032,747	17,794,164	18,076.111
Overdrafts	17,993	28,939	22,403	22,080	22,587
Customers' liability on account of letters of credit	14,789	6,116	8,706	7,482	11,015
Customers' liability on account of acceptances	440,411	539,097	624,571	655,405	652,001
United States Government securities owned[1]	4,036,899	3,660,943	3,506,426	3,081,156	2,941,655
Stock of Federal Reserve Bank	82,729	86,810	87,434	92,435	94,485
Other bonds, stocks, and securities[2]	2,947,967	3,190,272	3,224,007	3,175,951	3,124,897
Banking house	402,726	424,995	432,780	453,922	464,634
Furniture and fixtures	45,402	49,600	50,405	55,808	57,763
Other real estate owned	68,775	71,459	69,177	70,819	69,066
Lawful reserve with Federal Reserve Bank	1,723,774	1,825,152	1,903,814	1,865,638	1,838,648
Items with Federal Reserve Bank in process of collection	369,612	597,385	579,235	580,063	615,116
Due from banks, bankers, and trust companies	2,125,074	2,575,356	2,518,709	1,874,173	1,824,041
Cash in vault	559,433	602,992	691,173	620,897	621,817
Exchanges for clearing house, also checks on banks in same place	1,188,101	1,294,043	1,509,006	867,427	1,228,799
Outside checks and other cash items	109,046	134,379	147,276	102,996	126,269
Redemption fund and due from United States Treasurer	38,484	38,689	41,489	37,187	38,505
Approximate interest earned but not collected	67,362	67,530	69,354	66,070	73,728
Other assets	114,681	62,788	97,544	323,899	313,164
Total	29,243,729	31,860,508	32,616,256	31,748,572	32,194,301
LIABILITIES					
Capital stock paid in	1,489,792	1,565,871	1,593,753	1,695,555	1,717,014
Surplus fund	1,292,716	1,343,684	1,375,780	1,446,915	1,480,456
Undivided profits, less expenses and taxes paid	482,889	572,682	491,893	588,697	561,427
Approximate interest and discount collected but not earned	66,306	74,482	76,582	88,786	93,174
Amount reserved for taxes accrued	60,227	64,681	55,808	62,560	67,689
Amount reserved for interest accrued	24,302	40,410	24,843	39,404	26,474
Due to Federal Reserve Banks	11,876	16,435	14,189	21,547	24,682
Due to banks, bankers, and trust companies	3,650,502	4,078,615	4,091,400	3,524,359	3,461,016
Certified and cashiers' or treasurers' checks outstanding	704,349	789,035	906,515	518,517	648,361
Demand deposits	13,195,072	14,849,003	15,156,169	14,833,215	15,067,172
Time deposits	4,343,382	5,049,493	5,304,793	5,747,532	5,910,926
United States deposits	902,339	386,309	648,555	190,168	260,179
Bills payable with Federal Reserve Bank	1,368,112	1,401,373	1,190,331	1,246,721	1,122,067
Bills payable other than with Federal Reserve Bank	68,136	71,703	71,488	133,497	155,443
Cash letters of credit and travelers' checks outstanding	24,875	13,763	17,173	36,109	28,896
Acceptances	466,586	565,676	641,018	673,852	673,565
National bank notes outstanding	676,657	680,344	685,237	687,931	687,653
United States Government securities borrowed	233,638	167,228	182,665	123,143	130,860
Other bonds and securities borrowed	6,697	6,429	5,578	6,119	4,582
Other liabilities	175,276	123,292	82,486	83,945	72,665
Total	29,243,729	31,860,508	32,616,256	31,748,572	32,194,301

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[1] Includes U. S. Government securities borrowed by national banks.

[2] Includes other bonds and securities borrowed by national banks.

A steady growth of loans and discounts from 14,890 millions on June 30, 1919, to 18,076 millions on June 30, 1920, is indicated, notwithstanding the fact that loans secured by government war obligations, *i. e.*, by Liberty bonds, Victory notes, and Treasury certificates, were liquidated in considerable volume during the year. Figures showing the holdings of such loans are not available for all member banks, but only for those member banks in leading cities which report weekly to the Federal Reserve Board and whose loans constitute about 80 per cent of all loans of member banks. A decrease in loans secured by government war obligations (exclusive of amounts rediscounted with Federal Reserve banks) from 1,381 millions on June 27, 1919, to 773 millions on April 30, 1920, is shown. Since then a further reduction in these holdings has taken place, the July 16 total being about 736 millions. Loans secured by stocks and bonds, and representing to a large extent loans for speculative purposes including stock exchange loans, show no material change from the high level of the summer of 1919. On August 29, 1919, the earliest available date, such loans amounted for the reporting member banks to 2,915 millions, whereas on April 30, 1920, they aggregated 3,170 millions, and on July 16, 3,046 millions. The larger part of the growth of the loan burden of the banks in the Federal Reserve System is thus attributable to the increase in ordinary commercial loans, which is due in large measure to the general spread after the war of speculation in securities, land, and commodities, and, during the more recent period, also to the increase in "frozen" credits due to difficulties and delays in transportation.

In harmony with this increase in loans and discounts, individual demand deposits of the member banks show an increase from 13,195 to 14,833 millions for the period covered by the table, and time deposits an increase from 4,343 to 5,748 millions. Government deposits, on the other hand, declined from 902 millions to 190 millions, and bank deposits ("due to banks, bankers, and trust companies") from 3,650 to 3,524 millions.

In connection with the just noted decrease in the amount of paper based on government loans, it is of interest to compare the amount of funds of all the banks in the country that are tied up in holdings of government securities and in loans based on such securities. On June 30, 1919, this amount was estimated at between 6 and 6½ billions. Judging from the amount of liquidation reported by the member banks, the amount thus tied up at present is below 5 billions, probably nearer 4½ billions. This reduction reflects the smaller floating debt of the government, *i. e.*, the smaller amount of Treasury certificates outstanding, also the steady absorption by the public during the year of Liberty bonds and Victory notes. It indicates that during the year bank funds have been gradually released from service to the government and placed at the service of commerce and industry.

During the war, the Federal Reserve Board kept its discount rates low enough to permit the member banks to carry government obligations either for themselves or for their customers who were purchasing government war securities on the partial payment plan. It was not until November, 1919, that the board felt justified in launching a policy of advancing rates. Since that time decided advances have been made. In the early part of 1919, rates on commercial paper varied at the different banks in accordance with maturities from 4 to 5½ per cent, whereas at the present time they are 6 per cent at eight of the banks, and 7 per cent in the Boston, New York, Chicago, and Minneapolis banks. That this advance in rates has had a tendency to check the rate of credit expansion cannot be doubted. In March, 1919, the earning assets of the Reserve banks aggregated 2,348 millions and in November 2,923 millions, an increase of about 575 millions, whereas in June, 1920, they were about 3,183 millions, the increase over the November figure being about 260 millions. The growth of credit during the most recent period was thus only about one-half as great in absolute volume as the growth during the immediately preceding period of about equal length.

Although an advance in discount rates is the traditional method at the command of the Federal Reserve system with which to check credit expansion, it has been realized by the board that in many cases the principal danger was not from general expansion but from overloaning to individual banks which called upon the Federal Reserve banks for much more than their pro-rata share of loanable funds. To enable the Federal Reserve banks to exercise control over this matter, an amendment to the Federal Reserve Act was recommended by the board and passed on April 13, 1920. This amendment authorizes the Federal Reserve banks to charge rates "graduated or progressed on the basis of the amount of the advances or discount accommodations extended by the Federal Reserve Bank to the borrowing bank." Four of the Reserve banks, those at Atlanta, St. Louis, Kansas City, and Dallas, have adopted systems of progressive rates under which a member bank obtaining accommodation in excess of its basic line, which is determined differently by the various Reserve banks, must pay a rate of discount increasing progressively with the amount of the excess borrowings. The effect of the adoption of these plans has been to distribute the loans more evenly among a larger number of member banks in each of the four districts, and thus to diminish somewhat the concentration of borrowings within a small number of large banks. It may be added in this connection that general restriction and contraction of credit have never been the objects aimed at by the Federal Reserve policy. The aim has been, rather, to improve the character of credit accorded by the Federal Reserve and member banks, and in harmony with this view no uniform method is pursued by the Federal Reserve banks. It is recognized by the Federal Reserve Board that the problem of wise control of the flow and volume of credit by the Federal Reserve banks is regional in its character and accordingly the Federal Reserve banks have been allowed considerable latitude in the matter of choice of credit control.

The effect of rate advances and of progressive rates on the cost of accommodation at the Federal Reserve banks may be seen from the following table of rates of earnings from different classes of investments.

It will be noted that the average returns from all investments of the Federal Reserve banks advanced from 4.01 per cent in June, 1919, to 5.51 per cent in June, 1920.

To sum up, it may be stated that the rapid expansion of bank credit after the

RATES OF EARNINGS FROM INVESTMENTS OF THE FEDERAL RESERVE BANKS FROM JUNE, 1919, TO MAY, 1920

Date	Bills Discounted	Bills Bought in Open Market	United States Securities	Total Investments
1919	*Per cent*	*Per cent*	*Per cent*	*Per cent*
June	4.20	4.19	2.33	4.01
July	4.15	4.27	2.24	3.98
August	4.13	4.22	2.21	3.93
September	4.17	4.27	2.17	3.91
October	4.15	4.22	2.18	3.95
November	4.40	4.33	2.22	4.16
December	4.55	4.54	2.19	4.29
1920				
January	4.71	4.79	2.18	4.46
February	5.20	5.06	2.18	4.88
March	5.49	5.47	2.10	5.12
April	5.58	5.70	2.10	5.23
May	5.66	5.77	2.22	5.36
June	5.89	5.98	2.24	5.51

war, when the need of assisting the government by low discount rates became less urgent, induced the Federal Reserve Board and the Reserve banks to advance discount rates and to take measures toward the wider diffusion of borrowings through the adoption of progressive rates. The results of this policy are seen in a definite slowing down of credit expansion, a decided liquidation of loans contracted for speculative and non-essential purposes, and a somewhat lessened concentration of credits at Federal Reserve banks within a relatively small group of member banks.

M. Jacobson and E. A. Goldenweiser.

LIFE TABLES FOR THE CITY OF HAVANA*

A set of life tables for the city of Havana has just appeared in the official sanitary bulletin of the Republic of Cuba. These tables were prepared by Dr. Vega Lamar, chief of the Bureau of Records and Correspondence. They are the first tables not only for Cuba but for any of the Latin-American countries. They are, therefore, of special interest to American demographers and all the more so because they appear to have been well done after the method outlined by King in his supplement on life tables prepared for the seventy-fifth annual report of the registrar general of England and Wales.

There are six tables in all; the first two are for whites, males and females, respectively; the second two for negroes of both sexes; and the third two for mulattoes. The last are more accurately called "mestizos," that is, half breeds. But, as the Indian element is negligible in the present population of Havana, this term is equivalent to a mixture of whites and negroes, for which the word mulatto is the most accurate translation. The period covered is the decennium between 1904 and 1914, the population data being based on the two censuses of 1900 and 1907.

At age zero, the curtate expectation of life of white males and females in

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* Sanidad y Beneficencia, Boletin Oficial de la Secretaria, *vol.* XXII, Nos. 1, 2, and 3, July, August, September, 1919, pp. 59–74. Ministry of Health and Charities, Habana.

Havana was 42.0 and 46.2 years, respectively. These figures are approximately five years lower than for white males and white females in cities of the original registration states of the United States in 1910. The differences lessen somewhat with advancing age, especially in the case of females. At age twenty, the difference is about four years for males and about three and one-half years for females. At age forty, white males in Havana have an expectation of only twenty-one years, which is nearly four years less than that for white males in American cities. White females show a difference only of one and one-half years. At age fifty, there is still a difference of three years between the white males of the two areas, but the difference for females is only one-half year. The death rate for white males at this age is two-thirds higher in Havana than in American cities. At age sixty, Cuban white males are still two years behind in expectation, whereas the white females of Havana have caught up with the American figures. The striking fact of this table is the marked superiority in the longevity of white females over white males in the city of Havana.

The tables for the negroes of Havana are very instructive, although they are not quite comparable with those for the negroes of the original registration states because the latter include the mulattoes which form so large a part of our colored population. At birth, the curtate expectation of life of a negro male in Havana is 34.8 years as compared with 33.6 in our registration states; of a negro female, 38.9 years in Havana and 37.2 years in the United States. At the earliest ages, there seems to be a somewhat better expectation for the negroes of Cuba than for those of the registration states. But this advantage is soon lost; for at age five, the expectation of negro males in Havana is 40.5 years as compared with 43.8 for negro males in the United States, and 42.4 for negro females in Havana as compared with 45.9 for negro females in the United States. The more favorable situation of negroes at age zero in Havana may be due to the lower infant and early childhood mortality rates in that city than among negroes in American cities; but the element of poor death certification of negro infants may also be a factor. After age five, the death rates for Havana negroes are uniformly higher than for American negroes at the corresponding age periods, and the expectation of life is lower.

The figures for mulattoes are very surprising. At birth, the curtate expectation of life for males is 38.1, or four years less than for white males and three and one-quarter years more than for negro males. Female mulattoes show an expectation of 39.8 years, which is six and one-third years less than for white females and one year more than for negro females. The actual death rates during the first few years of life are high for both sexes of the mulattoes. But these decline rapidly and by age three the rates for both sexes are lower than for negroes; by age five they are lower than for white males, and at age forty-five than for white females. We, therefore, find the anomalous condition of a higher expectation of life for mulatto males and females than for white males and females after certain ages. What it is that accounts for the apparently superior longevity for persons of colored blood is not indicated in the report. It will be well worth while for the sanitary authorities of Cuba to analyze the details of mortality by causes of death in order to determine just what the explanation may be. Certain irregularities in the figures for female mulattoes at the ages after forty-five suggest that the table may be defective at these points.

The tables altogether confirm what has been known with regard to health conditions in Cuba under the present administration. Much excellent work is being accomplished, but much remains to be done. It should not be a difficult matter for the people of Havana to show even better conditions of the death rate and of the expectation of life in the next table—say ten years hence. The most promising results will follow from an attack on the problems of infant mortality and of tuberculosis. Cubans are, obviously, a hardy people, living under very favorable conditions of nature. The old dangers to life in the tropics no longer menace them. Plague, yellow fever, cholera, and the other scourges are matters of the past. As with us in the United States, the health program of the future will consist in developing more intensive work along the lines of personal hygiene under public direction. The Cuban administration of the public health may be expected to make good its efforts along such lines, as it has done in the control of the tropical diseases.

Louis I. Dublin.

INTERNATIONAL STATISTICAL ORGANIZATION UNDER THE LEAGUE OF NATIONS

Under Article 24, Part I, of the Peace Treaty, all international bureaus and commissions for the regulation of matters of international interest are to be placed under the direction of the League of Nations. If the parties concerned agree, this may also be done with similar international bodies which are already in existence. In August, 1919, the application of this section to the organization of statistics was the subject of a conference held in London under the direction of the Economic and Finance section of the League. This conference was composed of representatives of the Institute of Agriculture at Rome and the International Institute at the Hague, and leading statisticians, their object being to discuss the relations of the League with these bodies, and also in general the way in which the new League organization could profitably assist the development of international coöperation in statistics.

It was the unanimous opinion of this conference that it would be of great advantage if all the work in the statistical field whose accomplishment is a necessity in the political life of nations could be organized under a centralized system. The plan suggested was that of a central advisory council to meet normally at the seat of the League. With regard to the main classes of statistics, namely, (a) commercial, industrial, and economic, (b) agricultural, (c) labor, and (d) demographic, it was the opinion that these should be entrusted to different bodies under the League, the existing bodies being designated as the International Institute of Agriculture at Rome (agriculture), the International Labour Office (labor), and the Permanent Bureau of the International Institute at the Hague (demography).

The conference of August, 1919, was purely informal, the members being without mandates from their respective governing bodies, and it disbanded with a recommendation for the appointment of a committee for the purpose of drawing up more definite recommendations, and with a general instruction to the Secretary General of the League to obtain, in as representative a manner as possible, further views from international statisticians upon the questions considered. In accordance with the latter instruction, a conference took place in February, 1920, between the British Empire Statistical Conference, then meeting in London, and the Secretary General.

The matter as a whole, in the light of these and other representations, was reconsidered at the meeting of the Council of the League which took place in Rome in May, 1920. It was decided in effect to open the question *ab initio* and formally, by the appointment of a commission. The report on the question, which was presented by the Belgian representative, M. Destrée, after recounting the action already taken, pointed out that any attempt to realize the desirable object of uniformity and centralization in statistics raises problems which cannot be solved without the help of experts, "both statisticians and persons who make use of statistics." The report presented by M. Destrée and adopted by the Council proceeds:

> "I propose that, to this end, a commission be set up on the following lines: Each of the existing bodies, *viz.*:
>
> International Labour Office,
> International Institute of Statistics,
> International Institute of Agriculture,
> International Bureau of Commercial Statistics (Brussels),
>
> should be invited to nominate one representative. This committee should be completed by the addition of the following persons, whose work in the past points beyond question to such a choice:
>
> M. Lucien March, M. de Elola,
> Mr. R. H. Coats, M. Luigi Bodio.
>
> The commission thus formed should have power to add to its number by coöperating with other eminent statisticians whose collaboration it might desire. At the same time, it should use every effort to keep its numbers as low as possible."

It is understood that the commission thus appointed will assemble for a session of three or four weeks during September, 1920.

R. H. C.

MISCELLANEOUS NOTES

The progress of the Fourteenth Census work to July 1, 1920, is indicated in the following note. Up to July 31 the Bureau of the Census had announced the population of 4,629 cities, towns, and villages, and of 1,039 counties, having an aggregate population of 65,818,354. The latest comparative figures which have been prepared, showing the increase between 1910 and 1920 as against the increase for the same places between 1900 and 1910, relate to those places for which the populations had been announced on or before July 31. At that time the increase between 1910 and 1920 for the 4,157 cities, towns, and villages, and the 1,003 counties for which comparative figures for the last three censuses are available amounted to 10,118,718, or 18.5 per cent. For the same places the increase between 1900 and 1910 was 10,505,037, or 23.7 per cent. So far as can be judged from the figures thus far compiled, the decline in the rate of increase in population between 1910 and 1920, as compared with the rates for the decades 1890–1900 and 1900–1910, will be just about what might have been expected in view of the drop in immigration and the excessive mortality due to the war and the influenza epidemic. The Fourteenth Census of the United States was taken as of date January 1. The progress of the enumeration was materially impeded by the unusually severe weather conditions which prevailed in most of the northern states. Even in the south the enumeration was delayed by the torrential rains which occurred in many localities. As a result of these adverse conditions, the returns from the enumeration were not received at the Census Office as rapidly as had been hoped and expected. Nevertheless, they have come in promptly enough to enable the Bureau to get its tabulating force organized and at work about as soon as had been expected. The progress the Bureau is making on the work is gratifying, and justifies the prediction that the data will be compiled, published, and issued by June 30, 1922, as provided by law.

The statistical work which the United States Railroad Labor Board used in making its recent decision regarding wage rates was under the supervision of Professor Horace Secrist, of Northwestern University. As supervising statistician, Professor Secrist, though continuing his connection with the university, will coordinate the statistical activities of the Board and act in an advisory capacity on matters of statistical interpretation and presentation in the decisions, reports, and findings of the Board.

The government of France has sent out invitations to all foreign governments, inviting them to send representatives to a Conference for the Revision of the International List of Causes of Death. The Conference is to meet in Paris on October 11, 1920. Six countries have already accepted the invitation according to last accounts. The participation of the United States is under consideration by the federal government. It is hoped that a group of representative statisticians will be sent and that the personnel of the American commission will include, among others, those who have busied themselves during the last few years with the problems of classifying the causes of sickness and death, with special reference to the revision of the list in the forthcoming Conference in Paris.

The Amalgamated Clothing Workers have formed an organization for the collection of statistical material on a comprehensive scale. This work was begun in February, 1920, in preparation of evidence for the Rochester injunction suit. Under the direction of Dr. Leo Wolman of the New School for Social Research a survey was made of the effects of trade unionism on the industry. The results of this survey which should be of interest to statisticians are contained in an accumulation of statistical data relating to the course of wages in the industry from 1911 to December, 1919. The survey did not restrict itself to the study of general wage movements, but examined also such causal factors as the wages of male and female workers, piece and time workers, the variation of wages in the four major markets, the relation between the growth of organization and wage changes, and the concurrence of wage movements in the men's clothing industry with those in other industries. It is hoped that within the next year this and similar material will be made available for more general use. It is a hopeful sign of progress that the interest of the Amalgamated Clothing Workers in statistical information did not cease with the completion of a single survey. By the authority of the General Executive Board of the Organization, a permanent research bureau, organized to collect and interpret statistical material, was established early in July. Dr. Wolman has been appointed director of the bureau, and Mr. H. K. Herwitz, formerly with the United States Shipping Board and the United States Tariff Commission, is directly in charge of the bureau at the national headquarters of the union in New York City.

The Northwestern University School of Commerce is undertaking for the National Association of Retail Clothiers a clothing survey national in its scope. This survey extends to the complete membership of the Association and deals with the merchandising practices of retailers of clothing and the retail costs of distributing clothing. A preliminary report will be made on the results of the survey at the annual meeting of the National Association of Retail Clothiers which will be held in Chicago in September. A complete report will be published later by the Bureau of Business Research of the Northwestern University School of Commerce.

Dr. Frederick R. Macaulay and Dr. Wilford I. King have been appointed statisticians for the National Bureau of Economic Research, Inc. Dr. Macaulay leaves the Department of Economics of the University of California and Dr. King was public health statistician in the United States Public Health Service. Dr. King will still act as consultant for the Public Health Service.

Dr. R. B. Robbins, whose special field is mathematical statistics and actuarial theory at the University of Michigan, is on temporary leave of absence and will take up work as assistant actuary in the Department of Insurance in Missouri.

Dr. Royal Meeker has resigned his position as United States Commissioner of Labor Statistics and has sailed for Geneva, Switzerland, to take charge of the scientific section of the International Labor Office under the League of Nations. Mr. Ethelbert Stewart has been appointed as Commissioner of Labor Statistics, his appointment having become effective August 1.

The International Commission appointed for the purpose of advising the League of Nations as to the statistical organization and policy to be adopted, will hold its first meeting in September, probably at Brussels. The commission at present consists of one representative each from the International Labor Office, the International Institute of Statistics, the International Institute of

Agriculture, and the International Bureau of Commercial Statistics (Brussels), and of the following persons: M. Lucien March, Director of the General Statistical Office of France, Mr. R. H. Coats, Chief of the Dominion Bureau of Statistics of Canada, M. Luigi Bodio, President du Conseil Superieur de Statistique at Rome, and M. de Elola. Mr. Coats sailed from Canada in August to be gone probably for several months.

The Bureau of Applied Economics, Inc., Washington, D. C. has presented through Mr. W. Jett Lauck statistical briefs for organized labor in the recent hearings before the United States Coal Commission, before the United States Anthracite Coal Commission, and before the United States Railroad Labor Board. These statistical briefs have been separately published and consist chiefly of data on wages, profits, and cost of living.

An interesting and significant instance of the use of statistics is the work done for the Republican party on platform and policies. Early in 1920, the National Committee appointed an Advisory Committee on Policies and Platform whose function in part consisted in gathering facts and data to serve as a basis for the decisions of the Committee on Resolutions and of the convention. The work of this committee was in charge of a staff of some fifteen specialists largely from university faculties and selected for their expert knowledge in the various fields of public policy, concerning which there were to be planks in the party platform. The director of the staff was Dr. Samuel McCune Lindsay of Columbia University and the associate director was Dr. Jacob H. Hollander of Johns Hopkins University. Of especial significance is the decision to continue this work which was made by the National Convention in adopting unanimously a resolution authorizing the continuance and regularization of such investigations for the next convention.

NEW MEMBERS ELECTED SINCE MAY 1

Corporate Membership

National City Bank, 55 Wall St., New York City.

Regular Membership

Arrus, Oscar F., Lawyer, Formerly Chief of Statistical Section of Custom House, Calle Constitucion No. 20, Callao, Peru, South America.

Bernhardt, Joshua, U. S. Sugar Equalization Board, Inc., 111 Wall St., New York City. Chief statistician.

Biele, Edward, Norwich Pharmacal Co., Norwich, N. Y. Comptroller of the Company.

Bloom, Louis, 12 East 14th St., New York City. Accounting. Statistical work relating to clothing industry.

Brasher, Philip, Tidewater Oil Co., 11 Broadway, New York City. Industrial engineer, interested in management control statistics.

Brown, Helen E., Travelers Ins. Co., Hartford, Conn. Member of Actuarial Department.

Burke, William J., 18 Broadway, New York City. New York Transit Co., Standard Oil Subsidiary.

Cassmore, Melvin W., Bon Marche, Seattle, Washington. General research. Department store.

Chase, Charles H., 445 Quincy St., N. W., Washington, D. C. Economic Research, Council of National Defense.

Chen, Ta, 522 West 123d St., New York City. Student at Columbia University.

Clark, Mary A., American Social Hygiene Ass'n. New York City. Library research.

Coyle, Eunice S. Wadsworth House, Cambridge, Mass. Committee on Economic Research, Harvard University.

Crawford, N. Russell, Industrial Works, Bay City, Mich. Compiling and charting executive reports.

Crosby, Francis D., 55 Seaview Ave., East Norwalk, Conn. Student at New York University.

Croxton, Frederick E., Ohio State University, Columbus, Ohio. Laboratory assistant and research work.

Devereux, F. L., 118 South 19th St., Omaha, Neb. General Auditor, The Northwestern Group, Bell Telephone System.

Gini, Alfred S., Pathé Exchange, Inc., 25 West 45th St., New York City. Motion picture accounting. Auditor.

Groth, Herman A., 104 South Michigan Ave., Chicago, Ill. Treasurer of the Wm. H. Rankin Co., Advertising Agency.

Hahne, Ernest H., Northwestern University, Chicago, Ill. Teaching.

Hall, Lawrence L., 5 Wendell St., Providence, R. I. Manufacturing Dept., U. S. Rubber Co., New York City.

Henne, Edwin W., 715 Locust St., Des Moines, Iowa. Statistician and Actuary, Iowa Bonding & Casualty Co.

Holt, Dr. William Leland, University of California, Southern Branch, Los Angeles. Teaching.

Jeter, Helen R., 2559 Michigan Ave., Chicago, Ill. Research assistant, University of Chicago.

Johnson, George W., Western Electric Co., Inc., Chicago, Ill. Telephone manufacture.

Johnson, Verner A., 5 Magnolia Square, Dorchester, Mass. Charting trend, etc., firm for converting cotton goods.

Johnston, Paul I. Pierce Oil Corporation, 25 Broad St., New York City. Charge of General Statistical Department.

Keuper, Charles F., 4712 Drexel Blvd., Chicago, Ill. Division Sales Manager of Ford Roofing Products Co. of St. Louis, Mo.

Kilborn, Robert C., Interchurch World Movement, 45 West 18th St., New York City. Director surveys, statistical department.

Kollman, Sara E., 80 Schermerhorn St., Brooklyn, N. Y. Visiting Nurse Association, Brooklyn.

Knauth, Oswald W., 175 Ninth Ave., New York City. Secretary, National Bureau of Economic Research.

Lambert, Joseph, 601 Stone Ave., Brooklyn, N. Y. Business statistics, retail linen store.

Lemmon, Allen H., Gulf Refining Co., Pittsburgh, Pa. Charge of graphic chart department.

Lewis, Cleona, University of Chicago, Chicago, Ill. Assistant in the School of Commerce and Administration.

Lowell, Ernest W., 145 Main St., South Manchester, Conn. Organization and Management of The J. W. Hale Company, Department Store.

MacKenzie, T. Findlay, 408 West 115th St., New York City.

Merwin, Margaret S., 5493 Cornell Ave., Chicago, Ill.

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REVIEWS

The Nation's Food: A Statistical Study of a Physiological and Social Problem. By Raymond Pearl, Ph.D., Sc.D., LL.D. Philadelphia and London, W. B. Saunders Company, 1920. Pp. 274.

Dr. Pearl's study of the nation's food problem "makes available for the first time a knowledge, to at least the first degree of approximation, of how much and what kinds of food the American people as a whole eat." It is a work that is extremely interesting to the student of statistical technique, and of national nutrition and dietary in connection with national food production and foreign trade. The occasion for the construction of this work was the participation of this country in the World War from the beginning, April 6, 1917, to the armistice of November 11, 1918, and the supply of food for some time thereafter to Allies and other peoples. Dr. Pearl was chief of the Statistical Division of the United States Food Administration.

In this work, materials are classified as (a) primary human foods, including plant materials, "and all animals or animal products in which the animal gets its nourishment from some source other than the primary feeds and fodders," and the primary feeds and fodders are plant materials used for the nourishment of domestic animals; and (b) secondary human foods, which include "all edible products of animals used for human food, the animals being nourished with primary feeds and fodders." The object of this classification is "to allocate the nutrient resources of the nation according to the usage made of them," and to avoid duplication.

Under each food classification as primary or secondary, the plan is to determine for each year from 1911 to 1917 (beginning July 1) the amount of the basic nutrients—protein, fat, and carbohydrate—produced, imported, and exported in the case of each item of food. Many of these items presented problems of great difficulty. Production may not have been estimated by another office of the government, as in the case of corn meal for instance, so that Dr. Pearl's division had to contrive its own procedure for estimating. Next, it was necessary to determine the quantity of each item of product used for human food. The entire potato crop, for illustration, is not so used; about 8½ per cent is used for seed, and as Dr. Pearl estimates seed and waste to be one-third, the estimated waste must be one-quarter.

The food product from which the three human nutrients of protein, fat, and carbohydrate may be derived is now multiplied by the appropriate factor to compute the production of the nutrients. These factors were chiefly those of Atwater and Bryant, but supplemental use was made of the factors of other investigators. As published, the gross nutrient source product, and the three nutrients derived from it, are expressed in metric tons; but when the three nutrients are combined, their common denominator is calories.

Step by step, the operations lead to consumption, by means of the familiar formula: production + (imports − foreign exports) − domestic exports. Trade between contiguous United States and Alaska, Hawaii, and Porto Rico is "domestic," and is not included in the foreign trade statistics of this country, so that it is often necessary to add it to the foreign trade to arrive at results applicable to contiguous United States alone. This has been done in this study for Hawaii and Porto Rico and for shipments of fish from Alaska. The procedure is stated with particularity, but no mention is made of the subtraction of the foreign trade of the customs districts of Hawaii and Porto Rico from the foreign trade of the United States. The omission of this step, although it was technically required, is of no perceptible consequence.

From the foregoing description one should not form the impression that this study is mostly a matter of statistical mechanics. The fact is quite the reverse. Deductions from the gross product were often puzzling and made without tangible factors. In the case of a crop, for instance, these possible items of deduction had to be considered: (a) seed for next crop; (b) "loss from failure to harvest, and incomplete harvesting, frost damage, and other factors, lowering, in the field, the total net production"; (c) nutritional loss from plant diseases and weather injury which do not affect the quantity harvested; (d) loss from vermin (rats, etc.) and other causes in storage and transportation, including decay and spoilage of perishables; (e) manufacturing losses; (f) diversion to industrial, non-food uses. "Having made the best estimates possible of such general deductions, Atwater and Bryant's nutritive factors are applied to the residue remaining." These factors involve allowance for refuse in preparing food "as purchased" for eating.

The author is now prepared to "calculate with accuracy the total national food bill." As calculated for the six years 1911–12 to 1916–17, the average yearly consumption of protein in the United States was 3,654,572 metric tons, of fat 5,115,279 tons, and of carbohydrate 16,413,087 tons, and the total calories of these three nutrients is 129,931,314,000.

At this point an obvious difficulty arises. A statistical process may seem correct in the abstract, and yet fail to function satisfactorily. The reader, having followed the author's difficult path to this point, encounters an average that is comparable with one of similar character that has previously been established in nutritional laboratory work, namely, the nutritional requirements of the adult man per day. The work in hand does not give the reader the nutritional laboratory averages. Its own average for the seven years 1911–12 to 1917–18 is 4,288 calories, the entire population having been reduced to the equivalent number of persons of this standard unit; but this average is so absurdly high that the need of a reduction factor is evident. "In calculating the nutrients in earlier chapters, use has been made of factors which allowed for inedible refuse, so that all of the inedible portions of the foods as produced or imported have already been deducted in the calculations up to this point. However, it is obvious that there is still a considerable amount of loss or wastage of strictly edible material, which might be saved and consumed under a theoretically ideal system of preparing food for the table plus a conscientious ingestion of every bit of edible material. There is a considerable loss of nutrient values in the process of cooking as ordinarily practiced. . . . Another important factor is that of edible waste in garbage. . . . The figures here presented are really statements of consumption plus edible waste and should be so regarded."

The computed average "consumption" of protein per day per adult man for the six years 1911–12 to 1916–17 is 121 grams; of fat, 169 grams; of carbohydrate, 542 grams; of the three nutrients, 4,290 calories.

Without giving any facts with regard to percentages of reduction to be applied to his computed numbers of consumption to eliminate this edible waste, the author states that "it seems probable that of the protein in human foods left in the country for consumption, in the statistical sense, it seems safe to say that 5 per cent is lost in edible wastage; of the fat, . . . at least 25 per cent . . . ; of the carbohydrates, probably 20 per cent." After these reductions are made, the average eaten food per adult man per day becomes 114 grams for protein, 127 grams for fat, 433 grams for carbohydrate, and for the three, 3,424 calories. The fat average is regarded as still too high. The author is reconciled to the inclusion of this waste in totals, averages, and ratios by the reflection that, after all, the population actually "uses up" the indicated amounts of nutrients. This is shifting the point of view from that of physiological nutritional requirements, which has apparently been the purpose of the study, to that of a production that must be large enough to secure them for eating. The author's concession is sensible, since the study has been unable to establish the population's requirements of eaten nutrients. But the logic of the concession cannot stop here. If practically this waste must be suffered, so must consumption by rats, spoilage by weather, the retention of seed for the next crop, and perhaps the consumption by domestic animals.

Every one who has worked at production statistics knows how difficult of establishment Dr. Pearl must have found many items, especially in times of hurry. Estimates which seem acceptable in the present may be weakened as they recede into the past. This to some extent is true of the work in hand. Production estimates for 1917 taken from the *Monthly Crop Reporter* for December, 1917, were subsequently revised. The Food Administration's estimate of the wheat crop of 1917 was used. There is apparent disagreement of considerable degree between some items of fat and oil production in this work and the figures of *Bulletin* 769 of the Department of Agriculture, one of whose authors was chief of the Fats and Oils Division of the Food Administration. Some crops are reduced by a precise fraction on account of waste, or seed and waste, and the application of this fraction to the remainder should produce a number in agreement with the crop estimate that should be used; but, as far as tested, agreement has not been found, although the difference is usually small.

An error of some moment is found in the adopted estimates of meat production made by the Food Administration. If these estimates ever were accepted by meat statisticians outside of that office, they are not accepted now. The estimate of dressed weight of meat production for 1914–15 to 1916–17 is about 10 per cent too high, and for 1917–18 about 2 per cent too high. If the subject of edible offal had been treated, as was possible, by including the fat for making the oil that was used in making oleomargarine, and the exported oleo oil, those two food items need not have appeared in tables of secondary food production. The percentage that the edible offal is of dressed weight, already published in *Bulletin* 55 of the Bureau of Crop Estimates, should have been used, or some modification of it. For the use of that bulletin, one of the large slaughtering companies of Chicago weighed the separate edible-offal parts of over 10,000 meat animals.

This book was published in 1920 and it is regrettable that the imperfection of the hurried war work could not have been corrected in the meantime. This, however, would not have cured the greatest fundamental defect, and that is the liberty given to the statistician to create facts out of his mind. This he has constantly done in reducing production to human food production and in eliminating waste, not only from production but from the kitchen and the table.

Lest failure to mention may imply acceptance by default, objection should be made to the author's statement concerning the per capita food production. The ratio between food production and population is not the ultimate one, but it is food production per acre per capita. This comparison by no means sustains Dr. Pearl's rejoicing based on increased mere per capita production.

All are proud to acclaim the Food Administration and to regard it as one of the great successes of the war outside of army and navy operations. Yet encomiums may be misplaced, as to some small extent they are in this book. It seems not to be known that, notwithstanding meatless days and constant urgings to reduce meat consumption, the per capita consumption of meat in this country in the second year of the war (calendar, 1918) was higher than it had been for nearly a decade. But the Food Administration did not cause the orgy of meat consumption, any more than it caused the orgy of the buying of silks and shoes at $16 a pair. In wheat consumption, also, the per capita ratio kept up remarkably, in view of the restrictions and injunctions that wheat should be saved for the Allies. By dint of self denial on the part of some classes of citizens, the people as a whole managed to save per capita per week in 1917–18 less than one loaf of bread for Western Europe, but these citizens could not prevent an increased per capita consumption in 1918–19 over that of the preceding year.

A reviewer's bark may be worse than his bite, and certainly there is no biting to be done in this case. It is one of the saving graces of statistics that totals may be wrong, perhaps very wrong, and yet permit percentages and averages that are indicative of the approximate truth. It may well be the fact, as this book discovers, that, of the total energy value of the foods produced in the United States, the grains contribute 42 per cent, the meats 24½ per cent, the dairy products about 15 per cent, vegetables only 5 per cent, sugars less than 5 per cent, oils and nuts less than 5 per cent, poultry and eggs hardly 2 per cent, fruits less than 2 per cent, and fish about ⅓ of 1 per cent. This book abounds in opportunities for such interesting and important comparisons as this one, and the author has developed them with many illuminating results.

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Direct and Indirect Costs of the Great World War. By Ernest L. Bogart, Professor of Economics, University of Illinois. Carnegie Endowment for International Peace, Preliminary Economic Studies of the War, No. 24. New York, Oxford University Press, 1919. Pp. ix, 338.

The direct costs of war are the actual expenditures made by the belligerent nations in the conduct of the war. The author's task was to determine the cost for all the nations engaged in the World War. He has in fact done much more than this. Besides a statement of war expenditures, the book gives an account of the financial operations of the war—taxation, borrowing, banking, etc. This account is clear, detailed, and fairly complete for the leading nations, such as the United States, Great Britain, France, and Germany. In some of the other cases the record is brief and rather fragmentary. For this account students of war finance will welcome the book. It presents in clear and convenient form the facts of the subject which were obtainable during and immediately after the war. The author has not waited for all the original and official materials, nor has he undertaken to go far in analyzing the facts and drawing conclusions; but he has vastly lightened the task of any one who may wish to probe deeper into the economics of modern war finance, and he has put before us promptly the important facts as to the cost of the war and how it was met.

The net cost of the war to all the active belligerents appears to have been in the neighborhood of 186 billion dollars. The author mentions, but takes no further account of, the fact that the world's monetary units have all depreciated, and at different rates, during the struggle. As a matter of fact, the costs in different years and in different countries are measured by a changing unit. The dollar of 1918 is not the same as the dollar of 1914; and if the mark was worth twenty-five cents in 1914, it was not worth that in 1918. There is a certain mathematical fallacy in assuming to reduce to a common unit and combining in a single total quantities so diverse. However, the correction would have involved great difficulties, the margin of error would have been large, and the result would probably, for practical purposes, have been no more useful. Obviously, only the broadest and most general conclusions are intended to be drawn from such an aggregate as this.

Among the "indirect costs" of the war are included loss of human life, loss of property, loss of merchant shipping, war relief contributions, and the cost to neutral nations. This part of the book is less satisfactory than that which deals with direct costs. It is scarcely more than a hasty collection of various estimates and conjectures, without criticism or analysis. This is really all the author claims for it in his preface, when he characterizes the estimate of the indirect costs of the war as "merely the best guess which is possible at the present time." In particular, the attempt to reduce all the indirect costs to a total expressed in dollars (the figure is 152 billions) seems hardly worth the effort. Nevertheless, this part of the book is interesting and impressive, and it adds much to the cumulative picture of the gigantic, the unbelievable costs of modern warfare. This was the real object of the book, and the reader, though he peruse only the last three chapters, cannot fail to get the conclusion and be profoundly impressed thereby.

FRED ROGERS FAIRCHILD.

Yale University.

American-Canadian Mortality Investigation, based on the experience of the United States and Canada during the years 1900 to 1915 inclusive, on policies issued from 1843 to 1914 inclusive. New York, The Actuarial Society of America, Volume I, 1918. Pp. 378. Volume II, 1919. Pp. 139.

The principal object of this investigation is perhaps best indicated by a brief résumé of its history. In August, 1911, a committee of the National Convention of Insurance Commissioners, in a report submitted to that body, suggested that the Actuarial Society should "turn its attention to the construction of new mortality tables covering the general experience of the companies among normal lives." The Actuarial Society of America was at that time still engaged on the Medico-Actuarial Mortality investigation and could not take up any other work until that investigation had been finished. In October, 1914, the Convention of Insurance Commissioners again renewed its request, and the next year the Actuarial Society, having in the meantime completed the other investigation, appointed a committee and authorized it to proceed with the desired investigation. Although the principal object of the investigation was the construction of the mortality table representing the experience on American insured lives, the opportunity was taken at the same time to construct a similar table for men resident in Canada at date of application. In order, also, that the experience included in each table should be homogeneous, the principal table was confined to the experience on American men. However, the experience on American and Canadian insured women was separately investigated and compared with the primary tables.

At this same time, also, the opportunity was taken to investigate the mortality experience on men by groups of states in the United States, and by groups of provinces in Canada, the experience on men analyzed by plans of insurance, on insurance changed or converted from term policies, or renewed under renewable term policies, and on insurance by amounts; and also to make an investigation of causes of death.

In the introduction to Volume I is given a complete description of the rules applied to insure homogeneity and of the methods adopted in carrying out this investigation, including the mechanical tabulation of the cards and the graduation of the resulting data. The following summary will give an idea of the extent of the data in the various sections of the experience:

	Deaths	Total Exposures	Ratio of Exposures to New Entrants
American men	$436,345,200	$26,003,321,900	11.64
Canadian men	29,400,800	2,743,665,100	8.08
American women	10,878,500	787,819,500	8.58
Canadian women	672,500	69,144,100	8.35

The predictions which had been made with regard to the probable result of the investigation were in the main confirmed, the rates of mortality in the ultimate part on the table based on the experience on American men agreeing substantially with those in the M. A. table. The following schedule shows the rates of mortality at specimen ages and also the ratios of those rates to the corresponding rates given in the American experience table, in the United States life table for white males, and in the $0^{m\ (5)}$table:

Age	Rate of Mortality	Ratio to American Exp.	Ratio to U. S. Males (White)	Ratio to $0^{m(5)}$
25	.00431	.53	.78	.63
35	.00478	.53	.56	.58
45	.00794	.71	.63	.67
55	.01747	.94	.81	.84
65	.04066	1.01	.93	.96
75	.09194	.97	.99	.99
85	.19707	.84	1.03	.96

The rates of mortality in the graduated table are shown in select form, the select rates running into the ultimate at the end of five years. This procedure is justified by the figures contained in the following schedule:

Insurance Year	Ratio of Actual to Expected—Per cent
1st	63.4
2nd	84.1
3rd	87.4
4th	89.6
5th	91.5
6th	98.6
7th	101.2
8th	97.7
9th	104.4
10th	96.4
11th and subsequent	100.0

A comparison is given of the net premium rates and reserves according to the new table with those according to the American experience table, and indicates that for some plans and ages the new basis would show a lower reserve than the old, whereas on others it would show a higher. The statement is made that a valuation of one of the largest and oldest life insurance companies showed an aggregate reserve on the basis of the new table of 2 per cent greater than that on the American experience table, both at 3 per cent interest.

An interesting feature in connection with the graduation of both the American men table and the Canadian men table is that Makeham's second modification of Gompertz' formula was adopted, it having been found impossible to fit satisfactorily Makeham's first modification to the data. The graduated rates of mortality on Canadian men are higher than on American men at ages under twenty-seven and above eighty-one, but between those ages the Canadian men showed a lower mortality, falling as low as 84 per cent of the American man rate at age fifty-five.

The experience of insurance on the lives of women in the United States and Canada showed similar results when compared with the experience on men in the respective countries, the mortality in each case being higher on women during the first five insurance years and at ages under forty in the ultimate table, and lower at ages of forty and over in the ultimate table. On American women the aggregate death losses were 94.4 per cent of the expected according to the American men table, and in the experience on Canadian women, 97.9 per cent of the expected according to the Canadian men table.

In Volume II the first subject taken up is mortality according to plan. A summary of the results is given in the following schedule:

	Ratio Actual to Expected—Per cent
Ordinary life	102.2
19- and 20-payment life	94.3
19- and 20-year endowment	95.5
10-year term	102.2

It is interesting to note that the mortality experience on the 19- and 20-payment life policies is slightly better than on the 19- and 20-year endowment policies; this fact is possibly due to the offering of endowment policies on lives not considered eligible on the life plan.

The experience on 10-year term policies changed or converted during the original period was favorable, aggregating 88.8 per cent of the expected according to the general table. On those renewed or converted at the end of the period, on the other hand, the actual amounted to 108.4 per cent of the expected.

The analysis of mortality according to the habitat in the United States shows very interesting results, the mortality in the various sections ranging from 88.7 per cent of the expected in the wheat growing district of the Northwest to 124 per cent in a group of states bordering on the Gulf of Mexico. In Canada the results of the same kind of analysis were similar in so far as the location of best mortality is concerned, the ratio in the prairie provinces being 87.2 per cent of the general rate; but in this case the unfavorable mortality showing came from the provinces in Quebec, and is estimated to have been due to racial mortality. An investigation of the mortality among women in the Province of Quebec, although based on scanty material, indicated, so far as it went, a mortality 25 per cent above that among Canadian women as a whole.

In the analysis of the causes of death, the deaths from each cause are shown as percentages of total deaths and also as a ratio per $10,000 exposed to risk and are arranged in subdivisions according to duration and age at death. A comparison of the figures for the United States and Canada showed markedly greater death rates among American than among Canadian men from cerebral hemorrhage and apoplexy, organic diseases of the heart, diabetes, nephritis and Bright's disease, and a slightly greater death rate in the case of pneumonia. In the cases of accident, the Canadian death rates were higher.

The data pertaining to the investigation of mortality under policies for large amounts were not very extensive, but so far as the data went the indications pointed to a mortality in excess of the normal, the ratio for all policies of $50,000 or more being 116.7 per cent for all ages at entry and all durations combined; for aggregate amounts of $100,000 or over, this percentage was 131.2 per cent.

In that part of the work which is represented by Volume I, the committee of the Actuarial Society had the coöperation of a committee of Insurance Department actuaries appointed by the National Convention of Insurance Commissioners, and in the entire work it had the coöperation of a committee appointed by the American Institute of Actuaries, at the invitation of the Actuarial Society.

ROBERT HENDERSON.

An Index Number for State School Systems, by Leonard P. Ayres. New York, Russell Sage Foundation, 1920. Pp. 70.

Great interest has recently been aroused in educational circles throughout the country by the appearance of Dr. Ayres's book. Coming as it does from the pen of this expert on the subject of educational statistics, it presents in an authoritative manner the results of a careful study of statistical information with regard to education. The author computes for the several state systems an index number based upon ten sets of educational data. The data included are the following:

1. Per cent of school population attending school daily.
2. Average days attended by each child of school age.
3. Average number of days schools were kept open.
4. Per cent that high school attendance was of total attendance.
5. Per cent that boys were of girls in high schools.
6. Average annual expenditure per child attending.
7. Average annual expenditure per child of school age.
8. Average annual expenditure per teacher employed.
9. Expenditure per pupil for purposes other than teachers' salaries.
10. Expenditure per teacher for salaries.

It will be noted that the first five of these items refer to attendance, and the last five to financial matters. The question naturally arises as to the degree to which these items indicate the efficiency of educational procedure in the several states. Are there not other items, such as the achievements of pupils in standardized tests, the courses of study, etc., which would indicate more reliably the efficiency of the educational process? Dr. Ayres answers questions such as this in the following manner:

"If some great national agency were to undertake a survey of each of the forty-eight state school systems, it would surely report on many phases of their work not included in the items of the index. Among such phases would be the legal basis of the system, its organization, professional leadership and supervision, business management, course of study, teaching staff, plant and equipment, and the results of standard tests of classroom work.

"These elements, and others like them, are not directly included in the index, although some of them are crudely measured by the several items for financial expenditure. The sad fact is that, if there were available such information as surveys gather on most of the subjects suggested above, it would be still impossible to state the results in terms that could be included in an index number. The reason for this is that there is as yet little exact knowledge about education.

We do not know just what kind of teaching staff does the best work, or what kind of supervision is the most effective, or how many supervisors there ought to be, or how to measure organization in quantitative terms, or how to evaluate most of the other matters on which we report in survey making.

"Under present circumstances the best that can be done in an undertaking of the present sort is to take all the items for which continuous, reliable data can be secured and to combine them by as careful and impartial methods as can be brought to bear. In the present case it is to be regretted that only ten items could be found that seemed to meet the requirements that were laid down at the outset of the work. If the number of accurate and significant series used were greater, the reliability of the results would be enhanced."

The data and the index numbers based thereon are presented for the years 1890, 1900, 1910, and 1918. Tables are included showing the rank of each state for each of the four periods, and changes in rank are graphically indicated.

Table 13 presents two figures for each state for 1918, one figure based on the five data relating to attendance, and the other on the five financial in their nature. The author calls attention to a significant matter shown by this table. " . . . There is a generally close agreement between the educational figures in the first column and the financial ones in the second column in the matter of relative magnitude. In general, the high educational figures are accompanied by high financial ones, and the low educational totals by correspondingly low financial ones. This is one way of saying that a state having a long school term, high attendance, and many children in high school must pay more for the upkeep of its educational system than one which has none of these advantages. Another interpretation of the figures, which also is valid, is that the figures for school expenditures do have a close relation to those which show the amount of education given and tell how many are in high school, and that they are important indicators of the efficiency of the system and the quality of the education the children receive."

In reference to the accuracy of some of the data included, it should be noted that some times capital expenditures, such as loans for constructing new school buildings, are included by reporting authorities under the head of amounts spent for educational purposes, and sometimes they are not so included. Unless care be taken that uniform methods have been pursued in all cases, the validity of the relative standing of the several states would be impaired.

The author calls attention to the fact that large fluctuations take place in educational expenditures in cities on account of extensive building programs, and he states that "the use of the present index number would give misleading results if computed for cities." In some cases one or two large cities include a very large proportion of the population of a state. In such cases the accuracy of comparison among states may be impaired.

The year 1918 is, perhaps, not a good one for comparison of index numbers, because it occurred during a period when teachers' salaries were being adjusted throughout the United States on account of the increased cost of living. In some states a new salary scale had already been adopted in 1918, while in others a new scale was still under consideration. Under these conditions, comparison of index numbers in 1920 or in 1921 would give a more accurate indication of the rank of the several states. Of course, it may be stated in reply that the figures for 1918 show the conditions as they existed during that year.

In the summary, Dr. Ayres states that "in general the index number should be regarded as reliable rather than precise. Its methods are rigid and impartial, but not considerative nor interpretative. It measures results without considering causes. The purposes of the index number is to make it possible for state school systems to measure their progress from year to year, and to compare their attainments with those of their neighbors."

This book will certainly help to concentrate attention upon the importance of the ten items in the operation of state school systems, and will stimulate all those concerned with public education to increased effort. Dr. Ayres has done a valuable piece of work which will tend to benefit public education.

David E. Weglein.

Baltimore.

Some Dangers in Establishing a Pension System and the Proper Precautions, by Edward L. Dodd. (University of Texas Bulletin, No. 1905.) 1919. Pp. 1 to 26.

In this monograph, Mr. Dodd takes as a model the pension system of the Teachers' Insurance and Annuity Association of America, organized by the Carnegie Foundation. He points out the leading features of this system and urges that the pension systems which some institutions might establish independently should be modeled after the pattern of the Teachers' Association.

Mr. Dodd lays down the following principles as the cardinal requirements of a pension system:

1. The pension must be paid out of a pension fund accumulated and administered in accordance with sound actuarial principles. It must not be paid by an institution out of the current salary budget.

2. This pension fund rightly belongs to the teachers who are to be the pensioners, because it is made up of portions of their salaries, the payments of which have been deferred to pension age. Mr. Dodd argues that if an institution did not maintain a pension system, it would be in a position to pay larger salaries to the teachers because the amounts paid out in pensions could be distributed among the teachers in the form of larger salaries.

3. Since the instructor pays for his pension, either in the form of direct contribution into the fund or in the form of a reduced salary because his institution maintains the pension fund, each instructor should be required to pay the cost of his own pension only and should not be taxed to bear part of the cost of the pension of the older men. In other words, each generation should pay for itself.

4. If the periodical contributions to the pension fund are invested at 4 per cent compound interest, the cost of the pension to each beneficiary will be cut in two, for the reason that at such compound interest rate, the annual contributions to the pension fund in the course of 30 or 35 years are approximately doubled by the interest earnings. Therefore, if an institution pays pensions out of the current salary budget and not out of a reserve fund specifically created for

that purpose, the amount available for the payment of the salaries of the active instructors is diminished by approximately double the sum that would be required if pensions were paid out of a pension fund, where provision has been made for interest earnings.

5. If an instructor leaves the institution before pensions are payable, his interest in the pension fund should not be forfeited.

6. If he dies before the pension age, then the reserve accumulated to his credit in the pension fund, both principal and accrued interest, should be paid over to his family. The Tontine feature must not be employed in deferred pension systems.

7. The pension fund must be administered in accordance with the actuarial principle that the reserve must at all times be equal to the present value of the future pension obligations.

8. Where a pension system is in vogue, the pension should not be regarded as a future expense, but immediate provision must be made for these future obligations, and the reserve should be carried as a liability of the institution.

The big problem, of course, that confronts any institution that would establish a pension reserve fund, centers around the older teachers, who are near pension age, and for whose pensions special provision must be made in the pension fund. As a general principle, Mr. Dodd suggests that in order to establish a pension fund, an institution should declare a general increase in salaries, which increase is to be paid not directly to the teachers, but set aside for them into the pension fund. This increase is to be made retroactive in accordance with the length of service of the teaching staff, and a certain rate of compound interest is to be allowed on this retroactive increase, so as to bring the fund up-to-date. In this retroactive increase, account should be taken of the past rates of salary increases and also of the rate of increase in cost of living. But where this retroactive increase is to come from, Mr. Dodd does not state.

Mr. Dodd has treated his subject ably, and his pamphlet is well worth the study of college and other executives who are confronted with the pension problem. There is an interesting fallacy, however, in Mr. Dodd's reasoning. He assumes that each institution maintains a wage or salary fund for its teaching staff. This may be true where colleges pay their teachers' salaries out of the proceeds of special endowment funds. In such cases it may be presumed that the salaries are paid out of the proceeds or earnings derived from the endowment fund. But it does not necessarily follow that the pensions are paid at the expense of the active teaching staff, if an institution pays pensions out of the current salary budget. A simple change in bookkeeping would effect a division of the salary endowment fund into two parts, the income from one part to be applied to the payment of salaries, and the income from the other part to be applied to the payment of pensions. Thus, the payment of pensions out of a current salary budget may well be regarded as being made out of a pension fund. Such a system, however, makes no provision for teachers who leave the service of the institution. In this contention, Mr. Dodd will meet with unanimity of opinion among the teaching staffs.

Is not the following compromise solution feasible:

1. That when a college establishes a pension fund, all instructors should make contributions into this fund on the basis of age twenty-eight, which is the average age of an instructor on appointment.

2. As to the instructors who are between the ages of twenty-eight and fifty-five at the time of the institution of the pension system, the college should pay into the pension fund on their behalf the difference between the rate at their attained age and age twenty-eight.

3. This pension fund should not seek to provide for the pensions of instructors who are over fifty-five at the time the system is instituted. But when they reach the age of retirement, their pension should be paid out of the general salary fund of the institution. They should, however, contribute to this salary fund, the basic annual rates obtaining for age twenty-eight.

It would seem that the difficulties in the way of inaugurating a pension system on this basis should not be nearly so great as the practical difficulty of declaring a retroactive salary increase with compound interest over a number of years.

This suggestion is frankly a compromise, which may more readily solve in a simple manner some of the perplexing problems that arise in connection with the establishment of a pension fund system by any institution. In time, of course, as the older men die and the younger men who have been started correctly on the pension fund basis grow old, the fund will take care of all the pension requirements of the staff of the institution, whether the fund is administered by the institution directly or by an insurance company.

I. S. Adlerblum.

New York

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ON THE STUDY OF DISPLACEMENTS WITHIN A POPULATION

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I

Vital statistics have made rapid progress in the recent decenniums. It may be somewhat difficult for an outsider to realize this great change, but a study of the history of statistics will show it to be an indisputable fact. The progress may seem slight because the founders of political arithmetic and several generations of their disciples often anticipated results which the more scrupulous statisticians of the day have had great difficulty in proving. In fact, the modern statisticians are very careful with regard to methods as well as observations. They wish to be quite sure of the results they publish. Many of the apparent riches which the pioneers have left us and which in former days met with common assent, will be laid aside on account of their lack of real foundation. The conclusions reached by conscientious statisticians of today will, as a rule, stand the test of very severe criticism.

To characterize the present condition of statistics I shall mention two points of great importance. One is the great technical progress of which Mr. John Koren's *Collection of Memoirs of the History of Statistics*, published by the American Statistical Association, bears evidence. Undoubtedly, numerical observations nowadays are, as a rule, much more trustworthy than in former times and, moreover, we are able to specify them to a much larger extent. The second point is the constant effort to improve methods. Taking mortality statistics as an instance, it may be maintained that this discipline has reached a point of relative perfection, new methods for the construction of life tables having been devised and old methods having been improved. To a certain degree the same will hold good with regard to birth statistics which in several countries show a remarkable evolution.*

But in the history of science it will always be observed that whenever a problem has been solved, new questions will appear on the horizon. Even in the chapter of mortality there is a multitude of unsettled questions, for instance, with regard to heredity. And in close connection with mortality statistics we meet the problems of invalidity and infirmity. Again, there is the criminal man: we need statistical investigations concerning individuals who somehow or other have had a conflict with law. Further, a most important problem is that of migration, not to speak of the transition from one class of society to another, or of changes with regard to confession or conjugal condition.

These questions will generally require fresh observations. Thus a study of heredity will require numerous data from pedigrees and other sources. But at the same time it is worth while to ask whether the old material has always been exhausted, or whether an old census report may under certain circumstances give fresh output, just as a gold mine which has been given up for years often will pay if new technical methods are applied.

Of course even the most modern census will present numerous imperfections. It is sufficient to mention the ages distribution with its maximums at the round years of age, as 20, 30, etc. But usually there will be no insurmountable difficulty in mastering these imperfections so that sufficiently safe conclusions can be drawn. Some simple process of smoothing will, for instance, often be sufficient to do away with the disturbing effect of the irregular distribution according to age.

II

In order to have a point of departure for the present investigation, let us ask whether it is possible to calculate marriage rates from the distribution of the population according to conjugal condition.

A population with its constantly varying elements may be looked upon as a function with three dimensions. At a given moment t there will be a certain number of persons aged x. If ϵ is an infinitely small element of time, then the number of persons between the ages x and $x+\epsilon$ may be representedby $y=\epsilon p_{x,t}$. The value of y will be constantly varying on account of migrations, mortality, and births. It will, for instance, increase, say one per cent a year; its dependence on x will be still more striking, with a conspicuous decrease for each year that is added to the age. Now let the time t and the age x get the same addition ϵ; what influence will these changes have on the number of persons? The bulk of the group will evidently remain unchanged in the short interval of time, but migration and death combined may cause some small change, generally a decrease. Let δ_x be the rate of decrease from these causes, corresponding to the force of mortality; then we shall have:

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* In one of the last numbers of the *Journal of the Royal Statistical Society*, Dr. T. H. C. Stevenson has published an investigation based on the English Census of 1911, on the "Fertility of Various Social Classes in England and Wales," giving most interesting contributions to this chapter of vital statistics. I may be pardoned for quoting an investigation with a similar object, which I published in 1890 in coöperation with Mr. Rubin, dealing with results of the Census of 1880 in Copenhagen. (*Aegteskabsstatistik*, Copenhagen 1890, translated into German under the title: *Statistik der Ehen.*) Later on the Danish Statistical Department has treated the same question in official publications, giving more recent observations for the whole country. Denmark can thus claim priority with regard to this problem.

$$p_{x+\epsilon,\, t+\epsilon} = p_{x,\, t}(1 - \epsilon\delta_x),$$

or

$$\frac{dp_{x,\, t}}{dx} + \frac{dp_{x,\, t}}{dt} = -p_{x,t}\,\delta_x.$$

Of course δ_x is dependent not only on the age, x, but also on the time t, though in many cases we may be entitled to look upon this quantity as constant in the interval between two censuses.

Let, further, $\epsilon b_{x,\, t}$ be the number of bachelors aged x to $x+\epsilon$; then supposing their rate of migration and death to be δ'_x and the rate of marriage to be m_x, we shall have:

$$b_{x+\epsilon,\, t+\epsilon} = b_{x,\, t}(1 - (\delta'_x + m_x)\epsilon),$$

or

$$\frac{db_{x,\, t}}{dx} + \frac{db_{x,\, t}}{dt} = -b_{x,\, t}(\delta'_x + m_x).$$

Finally, we can put $f_{x,\, t} = \dfrac{b_{x,\, t}}{p_{x,\, t}}$, $f_{x,\, t}$ being the ratio between the number of bachelors and the total population. We get the following equation:

$$\frac{df_{x,\, t}}{dx} + \frac{df_{x,\, t}}{dt} = -f_{x,\, t}(\delta'_x - \delta_x + m_x).$$

As a rule it will not be difficult to calculate the expression on the left side of the equation with sufficient approximation. On the right side of the equation we have three unknown quantities, and the value δ_x is actually a sum of two quantities, say i_x the rate of migration and μ_x the force of mortality and the like, then we shall have $\delta'_x = i'_x + \mu'_x$. There are consequently as many as five quantities, and it might therefore be hopeless to try to find the marriage rate for bachelors. Nevertheless, in this case we are not prevented from reaching an approximate result. Usually bachelors will have a greater rate of mortality than married people, and the rate of migration will probably be greater also.

We shall thus very often have $\delta'_x > \delta_x$, and leaving these quantities out of consideration, we get a value for m_x, which as a rule is too high. But the difference between this value and the real one will generally be small. In the period of life in which most marriages take place, the rate of marriage will be 10 per cent or more, whereas the force of mortality and probably often the rate of migration, also, will be only a few per mille. If this is the case, the difference $\delta'_x - \delta_x$ cannot as a rule count much, and we will therefore often be justified in putting as a first approximation:

$$m_x = -\frac{1}{f_{x,t}}\left(\frac{df_{x,t}}{dx} + \frac{df_{x,t}}{dt}\right).$$

That is to say, if we know only the relative number of bachelors according to the census reports, we are able to find their marriage rate without knowing the number of marriages taking place.

In many cases it will even be justifiable to simplify the above equation still more by omitting $\frac{df_{x,t}}{dt}$. This may be necessary, if there is only one census available, or if the observations in the various census reports are not homogeneous. To see the extent of these changes in modern times we may look at the following table for Denmark, 1901 and 1911, giving the proportionate number (per 1,000) of bachelors and spinsters at different ages:

	Males		Females	
Age	*1901*	*1911*	*1901*	*1911*
20–25	881	876	746	727
25–30	497	488	418	400
30–35	246	235	252	254
35–40	151	145	191	194
40–45	106	115	156	173
45–50	89	96	135	155
50–55	77	85	127	138

If these numbers were constant from one census to another, they would tell us how a generation of bachelors or spinsters, if they were not exposed to mortality or migration, would by and by be reduced by marriage, and one census would be sufficient to calculate the approximate values of the rates of marriage. Evidently there is, however, a movement testifying to an increasing frequency of early marriages and a decreasing frequency of marriage in advanced years. From the numbers above we should find for males 20–25 years old with the year as unity:

$$-\frac{1}{f_{x,t}} \cdot \frac{df_{x,t}}{dt} = 0.0006.$$

In the following quinquennium of age we get 0.0018; the values are larger in the more advanced years, and on the whole more considerable for women than for men.

Still, these quantities are small compared to the variations with regard to the age x. The decrease from one quinquennium of age to another is so great that it will be necessary to take some care in the calculations. It may be advisable to go back to the values of $b_{x,t}$ and $p_{x,t}$, calculating their variations separately. As to the unit, it will generally suffice to calculate the relative numbers of bachelors for each year of age, and to use these numbers as approximate expression for $f_{x,t}$ for the median age, for instance 22, 5, 23, 5, etc. It will be advisable to let the numbers undergo some light smoothing process before calculating the rates of marriage. We thus reach the following results:

	CALCULATED RATES 1911		OBSERVED RATES 1911–15	
Age	*Males*	*Females*	*Males*	*Females*
17.5	....	0.019	....	0.016
22.5	0.069	0.110	0.063	0.103
27.5	0.149	0.113	0.156	0.119
32.5	0.135	0.078	0.127	0.063
37.5	0.073	0.029	0.080	0.033
42.5	0.032	0.019	0.041	0.017
47.5	0.019	.....	0.024	0.009
52.5	0.020	0.010	0.012	0.004

In comparing the results of the calculation with the observed numbers, we must bear in mind that the two columns do not cover exactly the same ground, one of them giving the rates at the moment of the census only (1 Feb. 1911), the other one giving the average 1911–15. Moreover, the observed rates are calculated for the ages 20–25, 25–30, etc., not for single years of age: finally, the various stages of calculation (including the variations with regard to t), as well as the whole smoothing process, may give rise to some difference. We must remember, as remarked above, that there is reason to consider the rates that have been found in this way as somewhat too high, the difference $\delta'_x - \delta_x$ having been left out of consideration. If we calculate the number of marriages which would take place in a population like that of 1911, according to the calculated and the observed rates, the former will give 4 per cent more marriages among men than the latter, and about 5 per cent more marriages among women. If we had no knowledge from direct observation, of the rate of marriage of bachelors, we might be justified in looking upon these calculated rates as a rather fair approximation. In some countries rates of marriage for the whole population are known, but not for widowers and bachelors separately. The described method would then help us to draw conclusions with regard to the rates of marriage for widowers as well as for bachelors.

It might be objected that all these calculations are superfluous if we are possessed of satisfactory direct observations, and that we have only to collect such observations in order to find the rates we wish to know. But this cannot always be the case. For example, we are in possession of a very interesting old Danish census of 1787, but we have no corresponding knowledge of the marriages, so that if we wish to form a picture of the chances of marriage of those days we shall have to resort to devices of the described character.

This census of 1787 is in many respects a most remarkable document; it gives—with 10 year intervals of age—the combined distribution of population according to sex, conjugal condition, and occupation. The numbers reveal the most striking difference between the old society and the modern one. Thus in the age of 30–40 among 100 males, no less than 29 were bachelors in 1787 as against 19 in 1911. In the following 10 year group there was a difference in the opposite direction, 9 against 12, and among females the difference was still greater, the corresponding numbers being 9 and 16.

These enormous changes are, however, chiefly a modern product. In 1801 the relative number in the age of 20–30 was 80 for males, the same as in 1787; for females the number was reduced from 64 to 63. In the following age-group the numbers were unchanged. Thus, in order to find the rates of marriage it will be justifiable to leave the variations with regard to time out of consideration.

The rates of marriage have been found for the median ages 25, 35, etc., by supposing the number of bachelors as well as the total number of persons to be represented by algebraic functions. Putting $b_x=m+nx+px^2$, we find, the central age being 0,

$$a=\int_{-15}^{-5}(m+nx+px^2)dx,\ b=\int_{-5}^{+5}(m+nx+px^2)dx$$

and

$$c=\int_{+5}^{+15}(m+nx+px^2)dx$$

where a, b, c, are three consecutive observed numbers of bachelors, and it is then easy to find m, n, and p; the differential coefficient of b_x for $x=0$ will be n. In the same way we can deal with the total numbers A, B, and C, and we find as an approximate value of the marriage rate:

$$\frac{6}{5}\left(\frac{C-A}{26B-A-C}-\frac{c-a}{26b-a-c}\right);$$

or we may choose a still simpler formula on the supposition that we can put $2b=a+c$ and $2B=A+C$: the formula will then be reduced to

$$\frac{C-A}{20B}-\frac{c-a}{20b}.$$

In this way the following approximate values of the rates of marriage per mille in 1787 have been found:

Age	*Males*	*Females*
25	39	53
35	138	185
45	132	92

The numbers show a striking contrast to the rates for 1911–15, given above. In the younger years there were proportionally few marriages, but after 30 the opposite is true.

To understand these enormous differences it will suffice to consider certain observations in various classes of society. For instance, we find among craftsmen in the town population the following absolute numbers:

	MASTERS		JOURNEYMEN	
Age	*Married and Widowers*	*Bachelors*	*Married and Widowers*	*Bachelors*
20–30	511	302	321	3,578
30–40	1,748	173	674	876
40–50	1,589	88	397	187
50–60	1,153	56	233	68

Taking masters and journeymen together we find that in the age of 20–30 years about 82 per cent were unmarried; in the following age group the number is only 30 per cent, between 40 and 50 it has been reduced to 12, and between 50 and 60 to 8. The married people were to be found chiefly among the masters. Thus, whereas 57 per cent of the journeymen between 30 and 40 were bachelors, the corresponding number among masters was only 9 per cent. It appears, further, from these observations that there was a constant stream from the class of journeymen to that of masters, but many journeymen reached the position of independent householders very late in life, and consequently marriage had to be put off. In most professions the journeyman lived in his employer's house, as a member of his household, till he settled as master. It is quite otherwise in modern society; most workingmen have no chance of becoming employers, so that they have very little inducement to put off marriage. It may even be the case that a young workingman aged 20 or 25 is frequently better off than he is in more advanced years.

III

Returning to the equation:

$$\frac{df_{x,t}}{dx}+\frac{df_{x,t}}{dt}=-f_{x,t}(\delta'_x-\delta_x+m_x),$$

we can use $f_{x,t}$ to signify other groups within the population. In the parenthesis, m_x will be the frequency of cases which tend to diminish the group, being negative, if there is an increase of the number. As with the marriages there will sometimes be the simplification that the variation with regard to t can be considered as zero, so that $\frac{df_{x,t}}{dt}$ can be left out of consideration. As an instance we can choose the feeble-minded. Under this heading the Danish census chiefly registers persons who are feeble-minded from birth or from a very early age. It is a mere exception that persons registered as feeble-minded are married. If the feeble-mindedness had often appeared later in life, the number of married persons in this group would undoubtedly be much larger. Thus m_x will probably be zero or at least very low (being an increase to the group, it will not be positive as the marriage rate). The variations of $f_{x,t}$ with regard to t will probably also be very small, though the census reports seem to indicate the reverse; the explanation seems to be that previous census reports have been less successful in the enumeration of the feeble-minded than was the census of 1911. Probably migration plays only a trifling part among idiots. In the parenthesis therefore we have chiefly to consider $\mu'_x-\mu_x-i_x$, μ'_x being the force of mortality among feeble-minded and μ_x among all persons, i_x the rate of migration. If fresh cases have a noteworthy effect, we shall have to add the negative quantity m_x. In the following table are shown the numbers of feeble-minded in Denmark, observed in 1911, among 10,000 of each age and sex, the numbers being adjusted by taking the average of three values as expression for the median:

Feeble-Mindedness in Denmark, 1911

Age	*Males*	*Females*
15–20	29.3	25.3
20–25	28.1	22.7
25–30	26.1	20.5
30–35	24.0	19.7
35–40	21.4	17.8
40–45	19.2	16.4
45–50	17.0	13.1
50–55	14.7	11.4
55–60	13.1	10.3
60–65	11.9	9.4
65–70	9.3	8.0

The yearly decrement in the age 20–25 would be about 1/10(29.3 − 26.1) = 0.32. Dividing by 28.1 we find a quotient 0.011. The normal rate of mortality being 0.004, the mortality of feeble-minded will be at least 0.015. In this way the following table has been calculated:

RATE OF MORTALITY PER 1,000

	IDIOTS		NORMAL PERSONS	
Age	*Males*	*Females*	*Males*	*Females*
20–25	15	25	4	4
25–30	20	19	4	4
30–35	25	19	5	5
35–40	28	25	6	6
40–45	30	35	7	6
45–50	36	46	10	8
50–55	40	35	13	10
55–60	40	33	19	14
60–65	59	45	27	21

These numbers can of course give only very rough estimates, but we can hardly read them otherwise than as testifying to a very high mortality among idiots. I may here refer to an investigation which I made several years ago concerning the mortality of idiots in asylums for feeble-minded, thus probably singling out a group still more delicate in health.* I found a mortality which was on an average nearly double the rates stated above; this seems to corroborate the results from the method here explained.

Turning to the insane, we find particulars of the same kind in the Danish census reports. In the following table are given the unadjusted numbers per 10,000 according to the census of 1911:

INSANE PERSONS

Age	*Males*	*Females*
15–20	1.9	2.3
20–25	9.4	9.3
25–30	20.6	16.6
30–35	27.7	22.4
35–40	32.8	35.6
40–45	40.3	40.7
45–50	38.7	53.5
50–55	43.8	53.1
55–60	44.0	57.4
60–65	46.7	51.8
65–70	48.9	58.5
70–75	46.1	47.3

It follows from these numbers that in a long period of life there is a constant increase of lunatics, in spite of the recoveries and in spite of their undoubtedly high mortality. Thus between 20 and 25 we find for males a yearly net increase of about 20 per cent of the existing number. If we prefer to ask what is the probability of a young man's becoming insane at the age 20–25, we shall have to compare these fresh cases to the number of non-lunatic men, viz., 9,991, and the lower limit of the probability of becoming insane within a year will be 0.2 per mille. But in this case the excess of mortality and the frequency of recovery will play such an important part that it is less satisfying to follow the described line of thought with regard to this material.

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* *Die Lehre von der Mortalität und Morbilität*, 2te ed., 1901, p. 237.

With regard to the blind and the deaf and dumb, the Danish census of 1911 gives the following numbers per 10,000:

	BLIND		DEAF AND DUMB	
Age	*Males*	*Females*	*Males*	*Females*
Under 5 years	1.2	1.1	1.4	1.3
5–10	1.9	1.8	4.8	3.6
10–15	3.5	3.0	7.2	8.0
15–20	3.1	2.5	9.0	5.7
20–25	3.2	2.0	7.4	6.2
25–30	2.5	2.8	9.8	7.0
30–35	3.6	3.0	8.7	6.1
35–40	3.2	4.0	14.5	9.3
40–45	4.1	4.7	8.3	6.8
45–50	6.1	4.8	7.5	6.4
50–55	8.3	6.7	8.3	5.0
55–60	10.3	8.0	7.1	7.3
60–65	12.2	9.6	9.0	6.6
65–70	16.2	17.2	9.2	7.7
70–75	20.3	22.4	5.9	5.9

The numbers of deaf and dumb depend to some extent on epidemics. Thus in Denmark the abnormal numbers between 35–40 in the year 1911 can partially be ascribed to epidemics from meningitis cerebrospinalis in Jutland, 1872–73.* Leaving out this group we find on inspection of the relative numbers that the frequency of this defect in the ages 15–35 is about the same as between 40 and 70. On the whole there seems to be no striking difference between the mortality of the deaf and dumb and of the general population. This was confirmed by a direct investigation by Dr. Mygind several years ago.†

The numbers concerning the blind are more complicated. The function $f_{x,t}$ cannot be looked upon as constant with regard to t, for there has been a conspicuous decrease in the blindness of newly-born owing to hygienic and medical progress. Thus the relative numbers in advanced years would be larger than if the present chances of the blind were used. In the equation

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* Westergaard, *loc. cit.*, p. 239.

† *Nationalökonomisk Tidsskrift*, 29, vol. 1891.

$$\frac{df_{x,t}}{dx}+\frac{df_{x,t}}{dt}=-f_{x,t}(\mu'_x+i'_x-\mu_x-i_x+m_x)$$

we may be entitled to leave $\mu'_x+i'_x-\mu_x-i_x$ out of consideration. The negative quantity m_x will thus mainly depend on the chances of becoming blind, as there is a very small chance for a blind person to recover; if we take no notice of the variations with regard to t, we shall somewhat exaggerate the probability. After 15 the frequency of blindness is nearly constant for a long series of years, but at about the age of 40 an increase is beginning. We find, for instance, that out of 100,000 the following numbers would yearly become blind:

Age	*Males*	*Females*
55–60	4	8
60–65	6	10
65–70	8	17

There is, therefore, an increasing probability with increasing age, and the female sex appears much more liable to blindness than the male.

It is unfortunately not possible to find the variations with regard to t, as the previous census report is not sufficiently complete with regard to the cases of blindness. But there is reason to believe that this imperfection of the material has comparatively slight influence on the numbers concerning the more advanced years of age which have been treated here.

Incomplete as all these observations on infirmity and invalidity are, they may serve as examples of the method explained, showing various possibilities under the discussion of the equation rendering the variations of the relative numbers.

IV

When two consecutive census reports are fairly correct, it may often be sufficient, instead of calculating the probabilities, merely to study the variations in the relative numbers. This will hold good with regard to the Danish religious statistics. The census registers the number of adherents to each church. The bulk of population is registered as belonging to the established (Lutheran) church, only small minorities belonging to other confessions. There is reason to believe that these minor groups have very much the same mortality as the total population, and that also the migrations with few exceptions (viz., the Jews and possibly also the Roman Catholics) are mostly of the same character. We are thus entitled to expect that the value of f_x in 1901 will be the same as that of f_{x+10} in 1911, if there are no particular movements influencing the numbers. Thus among Baptists we find in 1901, 455 males registered, aged 35–50 years. Ten years later there were 406, aged 45–60. In the whole population the corresponding numbers were 189,891 and 169,512. Out of 1,000 persons in 1901 there were 893 left in 1911. Calculating 993 per mille of the observed number of Baptists in 1901, we find 406, which is exactly the number observed in 1911. It thus seems probable that very little change has taken place in Denmark in this church in the ages concerned. In the following, I shall give some observations of this kind:

REFORMED CHURCH

	1901			1911			
Age	*Males*	*Females*	*Age*	*Males*		*Females*	
				Observed	*Expected*	*Observed*	*Expected*
5–15	99	89	15–25	89	88	104	84
15–20	55	47	25–30	47	46	61	44
20–35	115	122	30–45	113	108	122	114
35–50	98	125	45–60	85	87	102	113
50–80	131	131	60–70	66	82	83	87
	498	514		400	411	472	442

The difference between the observed and expected numbers is not very striking. The Reformed Church has, on the whole, kept its members.

The Methodists also show rather small changes, as will appear from the following numbers:

METHODISTS

	1901			1911			
Age	*Males*	*Females*	*Age*	*Males*		*Females*	
				Observed	*Expected*	*Observed*	*Expected*
5–15	468	482	15–25	270	415	427	457
15–20	125	178	25–30	106	104	170	166
20–35	258	443	30–45	280	240	449	414
35–50	329	451	45–60	277	293	430	409
50–80	254	392	60–70	210	159	293	260
	1,434	1,946		1,143	1,211	1,769	1,706

There seems to be some decrease in younger years, whereas in riper age the numbers are somewhat increasing.

Also, the Baptists show some stability between the two census years; in younger years, however, some decrease is perceptible.

BAPTISTS

	1901			1911			
Age	*Males*	*Females*	*Age*	*Males*		*Females*	
				Observed	*Expected*	*Observed*	*Expected*
5–15	575	647	15–25	349	509	479	613
15–20	178	235	25–30	136	148	195	219
20–35	419	615	30–45	403	391	605	574
35–50	455	564	45–60	406	406	537	512
50–80	479	654	60–70	323	300	396	434
	2,106	2,715		1,617	1,754	2,212	2,352

Compared to these results several other churches show great variations, for instance, the Catholic-Apostolic Church (the "Irvingites").

"IRVINGITES"

	1901			1911			
Age	*Males*	*Females*	*Age*	*Males*		*Females*	
				Observed	*Expected*	*Observed*	*Expected*
5–15	479	486	15–25	201	424	254	461
15–20	154	193	25–30	70	128	115	180
20–35	293	429	30–45	193	273	268	401
35–50	317	392	45–60	193	283	272	356
50–80	350	318	60–90	149	157	171	211
	1,493	1,818		806	1,265	1,080	1,609

The loss is perceptible in all periods of age, but especially in younger years. On the other hand, the Roman Catholic Church has made rapid progress, as the following numbers will prove:

ROMAN CATHOLIC CHURCH

	1901			1911			
Age	*Males*	*Females*	*Age*	*Males*		*Females*	
				Observed	*Expected*	*Observed*	*Expected*
5–15	552	623	15–25	1,239	489	1,265	591
15–20	228	242	25–30	469	189	516	225
20–35	591	769	30–45	890	551	1,094	718
35–50	488	630	45–60	465	435	624	571
50–80	282	387	60–90	193	177	272	257
	2,141	2,651		3,256	1,841	3,771	2,362

Also here we see that the increase takes place principally in the younger years. Part of the increase is probably caused by Polish agricultural laborers coming to Denmark for a shorter or longer time.

The Jews show interesting phenomena. The small mosaic congregation in Denmark seemed for a couple of generations to be in stagnation, or even to be gradually dying out. But of late years there has been an afflux from abroad, especially from Poland and Russia. This accounts for the peculiar changes in the age distribution which can be observed. In 1901 only 18 per cent of the total number were under 15, but in 1911 the proportion had risen to 26 per cent. In the same way as above the following results have been found:

JEWISH CONFESSION

	1901			1911			
Age	*Males*	*Females*	*Age*	*Males*		*Females*	
				Observed	*Expected*	*Observed*	*Expected*
5–15	215	220	15–25	379	190	448	209
15–20	124	115	25–30	253	103	241	107
20–35	364	411	30–45	512	339	533	384
35–50	389	408	45–60	362	347	416	370
50–80	412	516	60–90	239	258	351	342
	1,504	1,670		1,745	1,237	1,989	1,412

The increase is very conspicuous in the younger years; in more advanced ages foreign Jews have evidently not settled in Denmark to any extent in the period which we have here before us.

Finally, I shall give the main results with regard to persons who have been registered as not belonging to any confession. The number has been rapidly increasing, though it is still very small compared to the total population. The motive for declaring withdrawal from the established church or other confessions may of course lie deep within the personality; but very often some outward event will be taken as occasion, for instance, the wish to enter into civil marriage. The total number increased from 3,628 to 8,151, in 1911.

BELONGING TO NO CHURCH

1901			1911				
Age	*Males*	*Females*	*Age*	*Males*		*Females*	
				Observed	*Expected*	*Observed*	*Expected*
5–15	231	178	15–25	757	205	353	169
15–20	119	63	25–30	1,149	99	270	59
20–35	1,087	327	30–45	2,347	1,013	566	305
35–50	778	212	45–60	709	694	228	192
50–80	251	97	60–90	169	154	67	64
	2,466	877		5,131	2,165	1,484	789

After the age of 45 there is no great change, whereas in younger years the increase is appreciable, especially among males aged 25–30, the number rising from 99 to 1,149.

It is not difficult to find approximate net values of the rates of withdrawal from the church. Let $b_{x,t}$ be the number of persons outside the church, and $p_{x,t}$ the number belonging to some confession, and let the rate of withdrawals over and above the rate of reëntrance be $w_{x,t}$, then in a given element of time ϵ, the number of withdrawals will be $w_{x,t}\,p_{x,t}\,\epsilon$. If a census has been taken at 10-year intervals, the first census giving $p_{x,t}$, the latter $p_{x+10,t+10}$, and if the time passed is $t+n$, then we shall have as the expected number of withdrawals: $w_{x+n,t+n}\,p_{x+n,t+n}\,\epsilon$. Of these persons some will disappear in the period preceding the next census. It may be supposed that $p_{x+n,t+n}$ will be reduced to $p_{x+10,t+10}$ and the total gain found at this moment will be

$$p_{x+10,t+10}\int_0^{10} w_{x+n,t+n}\,dn,$$

or approximately

$$10 \cdot p_{x+10,t+10} \cdot w_{x+5,t+5}.$$

As an example we can take the gain in 1911 for males aged 25–30, altogether 1,050 or 105 per year between 1901 and 1911. The rate of withdrawals for the ages 20–25 will then be approximately 0.0011, the number of males aged 25–30 being in 1911 about 99,000, of whom

98,000 belonged to some confession. At the age of 15 we shall find 0.0002; for 30–35 years we shall have 0.0006. Above 40 the rate of withdrawals is reduced to a very small value, the excess being, according to the table, only 0.00001 per year.

V

Returning to the old Danish census of 1787, we may ask what displacement according to this census took place from one class of society to another. Practically, as remarked above, we may at this epoch look upon the population as being stable, the same proportions remaining from one year to another, even though there has been a small yearly natural increase of the population. Let $f_{x,t}$ be the relative proportion of some class to the whole population, then we may suppose that the differential coefficient $\frac{df_{x,t}}{dt}$ is approximately zero. Thus, the rural population had nearly the same proportion to the town population as 14 years later. By the census of 1901 the rural districts had, as in 1787, a population about four times the urban one, the urban population, as in the early census, being equally distributed between the capital and the provincial towns.

We may now ascertain to what extent the attraction of the towns has acted upon the population by using a similar reasoning as above with regard to the confession. For 1,000 males in the whole country aged 20–30 we should find 859 aged 30–40. Consequently the number of males in Copenhagen aged 20–30 would be reduced from 10,952 to 9,408 in the following decade, if there were no peculiar causes influencing the numbers. The actual number being 8,792, there is a difference of 616, probably owing to migrations in the age between 20–30 to 30–40, say about 30 years of age. For 100 persons expected, there were actually found only 93. In this way the following table has been calculated, showing how many persons were observed for 100 expected:

	MALES			FEMALES		
Age	*Copenhagen*	*Provincial Towns*	*Rural Districts*	*Copenhagen*	*Provincial Towns*	*Rural Districts*
10–20	107	98	99	96	96	101
20–30	170	122	90	152	129	92
30–40	93	96	102	100	96	101
40–50	78	92	105	85	98	103
50–60	82	95	103	90	102	101
60–70	71	89	104	88	102	101
Above 70	89	100	101	88	107	100

Thus, town life had a considerable attraction on males in younger years, more than counterbalancing the higher mortality which then as a rule menaced the life in towns. But soon after the tide turns and, as the combined effect of the greater mortality and of the migrations, the numbers are smaller in advanced years of age in Copenhagen and the provincial towns than in the country. At about 20 the male Copenhagen population had an increase of about 4 per cent per year from migration, whereas the rural districts were losing only 1 per cent. Also, the female population was attracted in younger years by the towns, the reaction being perceptible in the age of 30–40.

Still more interesting were the changes which took place within the artisan class. Only a few professions were allowed in the country, such as weavers, blacksmiths and wheelwrights, the towns having the privilege of binding most professions to them. The village artisans in the census report are given in total, whereas the artisans in towns are divided into two classes, the masters (with their male children), and the journeymen and apprentices.

The following table gives the main observations in absolute numbers for males:

	Towns			Rural Districts
Age	*Masters*	*Journeymen*	*Total*	*Total*
0–10	3,391	951	4,342	6,988
10–20	1,119	3,060	4,179	2,603
20–30	813	3,899	4,712	3,232
30–40	1,921	1,550	3,471	4,184
40–50	1,677	584	2,261	3,449
50–60	1,209	301	1,510	2,748
60–70	640	144	784	1,543
70–80	188	40	228	472
80–90	26	9	35	69
90–100	2	....	2	....
	10,986	10,538	21,524	25,288

It will be seen on inspection of this table that the ranks of the village artisans are very much reduced in a certain period of life; among 10 and 20, probably a large number of this group gained their living as servants, later returning to their profession. Some village artisans have possibly spent some time in the towns.

We can now try the same calculation as above for the towns and the rural districts, and we thus arrive at the following results, showing what percentage of the expected numbers was actually found in the various groups of age:

	Towns			Villages	Total of Artisans
Age	*Masters*	*Journeymen*	*All Artisans*		
10–30	54	181	123	76	99
30–50	159	39	84	124	103
50–100	90	75	86	96	92

As observed above, the country has a loss in the first period of life and a gain in the later period. On the other hand the towns gain in the younger years but lose afterwards. From material so defective as this it will, of course, be impossible to trace all the causes. Part of the loss in the higher ages in towns may be due to the unfavorable mortality; also, a number of former artisans may possibly be found in poorhouses.

We might have tried other methods of comparison. For example, it would be tempting to calculate the numbers which would be found if all the classes in view had the same age-distribution, taking as basis the number in each class pertaining to the youngest group of age. But the picture seems to be clearer if we choose the comparison which has been explained here.

The numbers of masters and journeymen show interesting features, as was remarked above, the stream going from the journeymen to the masters. For the sake of brevity I shall, however, omit entering into more details with regard to this question. But some observations concerning the structure of the rural population may prove instructive.

This structure of village society was at that time very simple. The majority of the population (altogether 330,000 males) were peasants (tenants and freeholders) with cottiers, servants, and laborers. About 135,000 males of all ages were registered as peasants with their children, holding lands of various size, sufficient to support a family; 35,000 were small-holders and 6,000 were registered as cottiers without land, working for the peasants or in the manors. There were 26,000 laborers, some of whom probably were engaged in work other than agricultural; this has been the case, too, with some of the 67,000 male servants. About 7,000 male persons were registered as poor. The following table will show the distribution according to ages:

MALES IN RURAL DISTRICTS 1787

Age	*Peasants*	*Small-Holders*	*Cottiers*	*Servants*	*Laborers*	*Poor*	*The Six Classes Combined*
0–10	38,936	11,059	2,142	2,479	8,250	1,822	64,688
10–20	22,545	2,229	408	25,683	1,717	501	53,083
20–30	15,089	2,011	461	25,380	1,417	176	44,534
30–40	17,869	5,163	741	8,355	4,005	233	36,366
40–50	16,863	5,613	556	2,867	4,407	349	30,655
50–60	12,347	4,684	599	1,299	3,691	697	23,317
60–70	7,767	3,074	779	466	2,046	1,442	15,574
70–80	3,106	1,157	428	94	432	1,458	6,675
80–90	491	154	84	7	21	393	1,150
90–100	16	5	7	....	2	39	69
	135,029	35,149	6,205	66,630	25,988	7,110	276,111

It will easily be seen, on inspection of this table, how people floated from one group to another, for instance, swelling the class of servants between age 10 and 30 and diminishing the number of peasants, and still more that of laborers. If we calculate the expected numbers according to the age-distribution in the whole country, we obtain the following results:

Expected Numbers

Age	*Peasants*	*Small-Holders*	*Cottiers*	*Servants*	*Laborers*	*Poor*	*The Six Classes Combined*
10–20	29,046	8,250	1,598	1,849	6,155	1,359	48,257
20–30	21,553	2,130	390	24,553	1,641	479	50,746
30–40	12,961	1,727	396	21,801	1,217	151	38,253
40–50	14,438	4,172	599	6,751	3,236	188	29,384
50–60	12,546	4,176	414	2,133	3,279	260	22,808
60–70	7,766	2,946	377	817	2,322	438	14,666
Above 70	3,726	1,259	396	205	907	863	7,556
	102,036	24,660	4,170	58,109	18,757	3,738	211,670

In the age of 10–20, the peasants have lost about one-fourth of their number, but the small-holders have lost nearly three-fourths, being reduced from 8,250 as expected, to 2,229 as observed. This is also the case with the landless working men (the cottiers and the laborers); also from the poor there is a constant stream, probably chiefly going to the class of servants. The five classes here mentioned have lost about 19,000, whereas the class of servants has gained nearly 24,000. Probably the ranks of the servants were also recruited from other classes, as that of the artisans; even the town population may have contributed a little.

In the following decennial age group (20–30), a loss is perceptible if all the six classes are taken together, whereas the class of servants has still a small increase. There is a considerable decrease in the peasant class, probably partly owing to the military service, the class of soldiers and sailors in this period of life showing a large addition.

In the next period of life (30–40) tide is turning. Five thousand persons are streaming back to the peasant class, proportionally still more to the small-holders and laborers. Altogether, the class of servants has lost 13,000 or nearly two-thirds of its expected number. There is still a small loss in the six classes, which, however, in the following period of life changes into a small increase.

The age of 40–50 shows in the main the same features as the foregoing one—the servants losing more than half of their number, whereas the other classes are winning. The decrease in the servant class is still perceptible in the following age-groups, but now this class has been so much reduced that its movements can have hardly any influence on the other classes; thus the number of peasants seems mainly constant. A considerable increase is shown in the poor class. The following abstract will give the main results. It tells what percentage of the expected number was actually found:

Age	*Peasants*	*Small-Holders*	*Cottiers*	*Servants*	*Laborers*	*Poor*	*The Six Classes Combined*
10–30	74	41	44	193	40	37	99
30–50	127	183	130	39	189	172	99
50–100	99	106	160	59	95	258	104

In order not to make this description too fatiguing, I shall confine myself to a corresponding abstract for the female population:

Age	*Peasants*	*Small-Holders*	*Cottiers*	*Servants*	*Laborers*	*Poor*	*The Six Classes Combined*
10–30	78	58	71	187	53	56	100
30–50	114	157	143	26	160	208	96
50–100	96	94	123	53	80	183	103

On the whole we have here the same features as for the male population.

The method used here to follow the movements of the various classes of population can, under certain circumstances, be applied to modern census reports. The well-known English *Supplementary Reports on Births, Deaths, and Marriages* give good information concerning the varying ages distribution in a large number of professions, and it will not be without value to look upon these observations from the point of view here described. As another instance I shall mention an investigation which I undertook many years ago in coöperation with Mr. Rubin; it gave us the opportunity of entering into the same question.*

In order to find the rates of mortality in various classes of the rural population, we undertook a study of the original schedules of the census of 1880 for one of the Danish provinces so that we could ascertain the distribution according to ages of the classes which we wished to investigate. But whereas these observations might be looked upon as fairly correct they were not truly representative without a correction for the corresponding number of deaths. There was reason to believe that several young servants, if attacked by a serious disease, as tuberculosis, left their service and returned to their homes to die there, and if the certificate of death then did not mention the deceased as a servant, the consequence would be that the mortality of the class concerned was overrated. In order to see the extent of this source of errors, it was therefore necessary to correct the numbers as far as possible by

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**Landbefolkningens Dödelighed.* Copenhagen, 1886.

supplementing the numbers of living persons and of deaths in each class of society with a probable number originating from the class of servants. Thus, among artisans the mortality between 10 and 15 would be reduced from 3.8 per mille to 3.2 per mille and between 15 and 20 from 4.8 per mille to 4.0 per mille. The ages distribution had much resemblance to the table for 1787, though probably the numbers for 1880 are somewhat less stable.

As to the census report for 1787 it would be easy to multiply applications of the method here explained. Thus, sailors and fishermen form one interesting group, the soldiers another one; but what I have developed here will probably prove sufficient to form an opinion concerning the method.

It must be acknowledged that several of the calculations described above have a less firm character than we should wish for in modern statistics. However, they will have this advantage over the old political arithmetic with its often very fantastic results, that they are supported by observations abounding in thousands of volumes of official statistics all over the world. From this stronghold it may be allowed to make excursions in fields which have not yet come under the plough of regular statistics.

VI

A little nearer the shelter of official statistics we meet the problem of calculating the rates of migration of a population, the rates of mortality having been fixed with tolerable accuracy from the lists of deaths and the census reports. In fact, knowing as we do the number of deaths of a certain generation between two moments of census, we can easily calculate the gain or loss from migration, and thus we have material for calculating the rates of migration according to age.

If the force of mortality at a given age x is μ_x and the rate of the net-emigration is i_x, then we have:

$$\delta_x = \mu_x + i_x$$

where δ_x is found by the equation:

$$p_{x+\epsilon,\, t+\epsilon} - p_{x,\, t} = -\delta_x p_{x,\, t},$$

knowing μ_x, we get i_x by subtraction.

From this equation we get the following:

$$p_{x+10,\, t+10} = p_{x,\, t} \cdot e^{-\int_0^{10} \delta_{x+n} dn},$$

or approximately

$$e^{-10\,\delta_{x+5}} = \frac{p_{x+10,\, t+10}}{p_{x,\, t}}.$$

The main results for Denmark for 1900–10 will be the following for males:

Age	*Force of Mortality Per Mille*	*Rate of Net-Emigration Per Mille*
5–10	3	3
10–15	2	5
15–20	3	15
20–25	4	15
25–30	5	4
30–35	5	1

After 45 the rate of migration is very small. It will be seen from these numbers that it is principally the young men who leave their country.

As to the female population between 5 and 25, the yearly excess of emigration over immigration will be about 3 per mille; after this age for a long period of life the rate is reduced to 1 or 2 per mille. The influence of age on migration is thus much less than among males.

THE ABILITY OF EUROPEAN IMMIGRANTS TO SPEAK ENGLISH*

By Louis Bloch

I. INTRODUCTION

The ability to speak English on the part of the foreign-born population of the United States is a matter of paramount importance in connection with the problem of Americanization. In order that the immigrant groups may participate fully in the life and activities of the natives, or even of the older immigrant groups which have already adopted the language of the land as their medium of expression, it is essential that they learn to use the language of this country. It will be shown in the following pages that the necessity of learning to speak English confronts about 90 per cent of the European immigrants who come to the United States and that the problem is one which affects primarily, if not wholly, the first generation of immigrants. The data on ability to speak English in the censuses of 1900 and of 1910 have been analyzed in this article with a view to finding out the status of the foreign-born population in regard to ability to use the English language.

II. SCHOOL ATTENDANCE

It is apparent from the data presented in Table I that the problem of speaking English is almost wholly one affecting the first generation

TABLE I

PERCENTAGE ATTENDING SCHOOL DURING 1909-10, BY AGE OF PERSON ATTENDING (THIRTEENTH CENSUS, VOL. 1, p. 1100.)

Age	Native white			Foreign-born white
	Total	Native parentage	Foreign or mixed parentage	
6 years	55.5	52.6	62.9	55.5
7 years	79.2	77.2	84.3	76.9
8 years	86.7	85.2	90.5	84.2
9 years	89.5	88.3	92.4	87.5
10 years	93.2	92.2	95.7	90.3
11 years	93.8	92.9	96.1	91.4
12 years	93.1	92.0	95.6	90.2
13 years	91.9	90.9	84.3	87.7
14 years	84.7	85.3	83.1	71.6
15 years	71.5	75.0	63.5	46.2
16 years	53.7	58.9	41.8	23.7
17 years	38.0	42.9	26.7	12.2
18 years	25.1	28.6	16.9	6.8
19 years	16.3	18.5	11.1	4.8
20 years	9.8	11.0	6.8	3.0

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* This subject is discussed by the writer in greater detail in *Bulletin No. 43* (mimeographed) *of the Division of Information Service of the Carnegie Americanization Study.*

of immigrants. Up to the age of 14 the percentages of native whites of foreign or mixed parentage attending school are higher than those of the native whites of native parentage. The native-born children of foreign-born parents go to school and learn to speak the English language. Above the age of 14 it will be seen that the difference in school attendance is in favor of the native whites of native parentage. Between the ages of 14 and 20 the proportion of the native whites of native parentage attending school ranges from 85.3 to 11.0 per cent as compared with percentages ranging from 83.1 to 6.8 for the native whites of foreign or mixed parentage.

It will be noticed that there is not much difference in school attendance between the foreign-born whites and the natives up to the age of 14, but that beginning with that age the difference is very marked in favor of the native whites. According to the census, "Economic conditions undoubtedly account in part for the lesser frequency of school attendance among the foreign-born of older ages. The fact that the foreign-born are concentrated in cities, where school attendance generally begins and ends at an earlier age than in rural districts, is doubtless also a factor. It should be borne in mind, however, that the pronounced decline in the proportion of school attendance among the foreign-born whites beginning at the age of 14 is not altogether caused by the fact that those in school leave at these ages, but is due in large part to the influx of immigrants of 14 years and over, who never go to school in the United States."*

The data as presented in the census do not reveal the kinds of schools attended by the respective nativity groups or the length of time school was attended. It is safe to assume, however, that only in a very small proportion of schools was the English language not taught and that the average length of time the individual attended school was sufficient to enable him to learn to speak English.

Since it is the native whites of foreign parentage and also the foreign-born whites under 14 years of age who generally attend school, it may be concluded that the problem of learning to speak English, as has already been said above, is one affecting primarily the first generation and largely those who are above the age of thirteen.

III. IMMIGRATION FROM ENGLISH-SPEAKING COUNTRIES

The following table (Table II) shows that 10.6 per cent of all immigrants who arrived from Europe during the decade 1901–10 came from English-speaking countries, which means that only about 90 per cent of the immigrants arriving in the United States are faced with the problem of learning to speak English. This table does not take into consideration immigrants from countries other than Europe, such as Asia, Mexico, or from the British possessions. But since the data submitted below are confined to the foreign-born whites, and since the numbers arriving from countries other than Europe are comparatively small, the estimate of those unable to speak English upon arrival has been confined to the European immigrants.

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* The Thirteenth Census, General Report and Analysis, vol. 1, p. 1101.

TABLE II

NUMBER AND PER CENT OF EUROPEAN IMMIGRANTS WHO ARRIVED IN THE UNITED STATES FROM THE UNITED KINGDOM DURING 1901–10. (COMPUTED FROM U. S. IMMIGRATION COMMISSION STATISTICAL REVIEW OF IMMIGRATION, PP. 93–96.)

	Number	Per cent
Total from Europe	8,136,016	100.0
United Kingdom	865,015	10.6
England	388,017	4.8
Ireland	339,065	4.2
Scotland	120,469	1.5
Wales	17,464	.2

IV. CENSUS DATA ON INABILITY TO SPEAK ENGLISH†

In each of the last four censuses an inquiry as to ability to speak English was included in the population schedule. In taking the census of 1890 the enumerators were instructed to return as English speaking any person 10 years of age and over "able to speak English so as to be understood in ordinary conversation." The following table (Table III) from the Thirteenth Census shows the number and per cent of

TABLE III

NUMBER AND PER CENT OF FOREIGN-BORN WHITES 10 YEARS OF AGE AND OVER UNABLE TO SPEAK ENGLISH, BOTH SEXES, FOR 1890, 1900, AND 1910. (CENSUS, 1910, VOL. 1, P. 1268.)

Census year	Foreign-born whites 10 years of age and over		
	Total	Unable to speak English	
		Number	Per cent
1910	12,944,529	2,953,011	22.8
1900	10,014,256	1,217,280	12.2
1890	8,786,887	1,371,044	15.6
Increase (or decrease)			
1900–10	2,930,273	1,735,731	142.6
1890–00	1,227,369	—153,764	—11.2

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† It is important in studying the statistics of ability to speak English to bear in mind the distinction between the ratio of non-English speaking to the total foreign-born population and the ratio of non-English speaking to the total number of foreign-born of non-English-speaking races. The latter proportion

foreign-born whites unable to speak English at each of the three preceding censuses.

It appears from this table that the number unable to speak English more than doubled from 1900 to 1910 and that the number unable to speak English in 1890 was greater than the number reported unable to speak English in 1900. The Thirteenth Census makes the following comment upon this absolute and proportionate increase in the number unable to speak English in 1910: "The proportion of foreign-born whites unable to speak English was decidedly greater in 1910 than it was in 1900. . . . The increase during the decade in the number of foreign-born whites 10 years of age and over was 2,930,273, or 29.3 per cent; the increase in the number of that age unable to speak English was 1,735,731, or 142.6 per cent. Thus of the total increase in the number of foreign-born whites 10 years of age and over, during the decade 1900–10, persons unable to speak English constituted approximately three-fifths. In the decade 1890–00 the number of foreign-born whites unable to speak English decreased by 153,764, or 11.2 per cent. . . . The increases during the decade 1900–10. . . are perhaps the most significant figures to be derived from the census returns relating to inability to speak English. The rapid increase in the non-English speaking element of the foreign-born white population is a fact of very considerable social consequence. The explanation of this rapid increase is, of course, to be found in the character of recent immigration. In the foreign-born white population returned in 1910 as unable to speak English, the actual number of immigrants unable to speak English, who came into the country during the decade 1900–10, must, in fact, considerably exceed the increase since 1900 in the number of foreign-born whites unable to speak English, as shown by the census returns, since a considerable number among the foreign-born whites returned in 1900 as unable to speak English must have died or left the country, or learned to speak English during the decade 1900–10."* An analysis of the statistics, however, leaves little room for doubt that

* Thirteenth Census, General Report and Analysis, vol. 1, pp. 1267–1268.

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is, of course, higher than the former. Of the 13,345,545 foreign-born whites in the United States in 1910, 2,572,123 (computed from Thirteenth Census, Vol. 1, p. 879), or 19.3 per cent were from England, Scotland, Wales, and Ireland. Assuming that of these English-speaking races the proportions of those 10 years of age and over is the same as that of foreign-born whites of all races, namely, 97.0 per cent, the number of persons 10 years of age and over of the English-speaking races was 2,494,959. Deducting this number from the total number of foreign-born whites, 10 years of age and over, the remainder, 10,459,570, represents the number of foreign-born whites 10 years of age and over of the non-English-speaking races. The total number of foreign-born whites 10 years of age and over unable to speak English in 1910 was 2,953,011, or 28.2 per cent of the total number of foreign-born whites 10 years of age and over of the non-English-speaking races. The per cent of the total foreign-born 10 years of age and over unable to speak English is only 22.8. The differences for each of the states could be estimated by the same method.

the increase in the decade 1900–10 is not so much due to "the character of recent immigration" as it is to an understatement in the number unable to speak English in the census of 1900. If the increase in the volume of recent immigration is the cause of the increase in the per cent unable to speak English in 1910, as compared with 1900, then, as will be seen from the following table, the census of 1900, as compared with the census of 1890, should have shown an increase in the proportion unable to speak English.

TABLE IV

IMMIGRATION TO THE UNITED STATES FROM NORTHERN AND WESTERN EUROPE, SOUTHERN AND EASTERN EUROPE, 1881–10. (ABSTRACTS OF REPORTS, VOL. 1, P. 64.)

Decade	Europe					
	Northern and Western		Southern and Eastern		Total	
	Number	Per cent	Number	Per cent	Number	Per cent
1881–90	3,779,315	79.7	959,951	20.3	4,739,266	100.0
1891–00	1,648,613	45.8	1,942,164	54.2	3,585,777	100.0
1901–10	1,910,700	23.3	6,302,709	76.7	8,213,409	100.0

Table IV shows that in the decade 1891–00 the immigration from southern and eastern Europe was more than double the amount of immigration from the same countries during the decade 1881–90. In spite of this fact the census (Table III) shows for 1900 a *decrease* in the proportion unable to speak English. It will be seen, on the other hand, that the total volume of immigration during the decade 1891–00 decreased by 1,153,489, or a decrease of about 24 per cent as compared with the decade 1881–90, and that the decrease was from northern and western Europe and not from southern and eastern Europe. During the decade 1881–90 the number of immigrants coming from northern and western Europe was 3,779,315, while the decade following the volume of immigration from these countries decreased by 2,130,702, or about 59 per cent. If the *character* of the immigration accounts for the variations in the proportions unable to speak English (Table III), it then follows that the smaller proportion of immigrants unable to speak English in 1900 was due to the decrease of immigration from northern and western Europe and the corresponding increase of immigration from southern and eastern Europe.

The tables next presented (Tables V and VI) throw considerable doubt on the reliability of the statistics of inability to speak English as shown in the census of 1900. An attempt has been made in Table V to correlate the increase in the number of foreign-born 10 years of age and over with the increase in the number unable to speak English. From the forty-eight states and the District of Columbia only the states which are particularly illustrative of the point in question are selected for incorporation in this table. It will be seen, for instance, that in 1900 New Hampshire showed an increase of 16,453 in the number of foreign-born 10 years of age and over and a decrease of 203 in the number unable to speak English in the same age group. The increase in the number of foreign-born whites in New Hampshire, as in other states, resulted either from direct immigration fromEurope or from migration from other states. Apparently this increase in the number of foreign-born in the state did not in the least increase the number unable to speak English in 1900 as compared with 1890, while in the decade 1900–10 a much smaller increase in the number of foreign-born whites 10 years of age and over was accompanied by even greater increase in the number unable to speak English.

TABLE V

INCREASE OF FOREIGN-BORN WHITES AND OF THOSE UNABLE TO SPEAK ENGLISH, 10 YEARS OF AGE AND OVER, 1890–00 AND 1900–10, IN SELECTED STATES

State	Increase of foreign-born whites				Increase of foreign-born whites unable to speak English			
	1900–10		1890–00		1900–10		1890–00	
	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent
New Hampshire......	9,434	11.3	16,453	24.5	9,676	56.6	—203	—1.2
Massachusetts	203,786	24.9	190,265	30.4	94,377	123.1	22,604	41.8
New Jersey..........	216,083	51.4	105,380	33.4	105,152	215.0	7,802	19.0
Ohio................	127,154	28.1	6,577	1.5	111,970	216.4	—13,740	—21.0
Indiana..............	15,194	10.8	—2,630	—1.8	29,392	259.2	—6,369	—36.0
Illinois..............	216,853	22.8	141,353	17.4	163,256	158.0	—28,023	—21.3
Wisconsin...........	—7,049	—1.4	8,724	1.7	33,868	39.0	—45,130	—34.2
Iowa................	—33,980	—11.2	—11,148	—3.5	11,625	45.5	—25,427	—49.9
Washington..........	134,448	133.8	17,595	21.2	21,753	570.2	—1,885	—33.1
California...........	191,942	61.2	25,988	9.0	55,901	297.3	—5,413	—22.3

In the state of Illinois the number of foreign-born increased during 1890–00 by 141,353, but the number unable to speak English decreased by 28,023 during the same period; however, in the decade 1900–10 an increase of 216,853 in the number of foreign-born whites 10 years and over was accompanied by an increase of 163,256 in the number unable to speak English. During 1890–00 the increase of foreign-born in Illinois was 17.4 per cent, accompanied by a decrease of 21.3 per cent unable to speak English, while during 1900–10 the increase of 22.8 per cent of foreign-born was accompanied by an increase of 158 per cent of those unable to speak English. Again, in Wisconsin an increase of 8,724 in the number of foreign-born during 1890–00 was accompanied by a decrease of 45,130 in the number unable to speak English, while in the next decade a *decrease* of 7,049 in the number of foreign-born was accompanied by an *increase* of 33,868 in the number unable to speak English. In Iowa the census figures also appear improbable. A decrease of 33,980 in the number of foreign-born, during the decade of 1900–10, was accompanied by an increase of 11,625 in the number unable to speak English, while during the preceding decade a decrease of 11,148 in the number of foreign-born was accompanied by a decrease of 25,427 in the number unable to speak English. The condition shown in Table V, though perhaps not impossible, certainly appears highly improbable.

Apparently the number unable to speak English in 1900 was understated by the census. The decreases for the United States as a whole and for the states separately in the number unable to speak English as shown in 1900 (Tables III and V), in spite of the large increase in the number of foreign-born, suggest inaccuracy in the figures on ability to speak English as given in the Twelfth Census. An examination of the schedule used in that census suggests the source of error. According to the official explanation, the column "Can speak English" was in 1900 included in the schedule "under the general heading 'Education,' together with three other columns covering, respectively, school attendance, ability to read, and ability to write. In tabulating the returns for 1900, it became evident that the number of negroes returned as unable to speak English, though not in itself large, was nevertheless almost certainly an overstatement, and an investigation led to the conclusion that errors had probably arisen from the arrangement of the columns of the schedule. In a great majority of cases for the whites, and in a large number of cases for the negroes, a correct return necessitated writing 'Yes,' 'Yes,' 'Yes,' in answer, respectively, to the three inquiries, 'Can read,' 'Can write,' 'Can speak English.' The returns seemed to indicate that in the case of illiterate negroes enumerators had in some instances carelessly written 'No,' 'No,' 'No,' even when the illiterate person was in fact able to speak English. . . . Owing to the evidence of error in the returns the results of the tabulation for negroes were not included in the report for 1900, and in the tabulation for the negro population no comparison can be made of 1910 with 1900."*

Since in the case of negroes the enumerators had in some instances carelessly written "No," "No," "No," in answer to the three inquiries "Can read," "Can write," "Can speak English," it appears highly probable that enumerators often carelessly wrote "*Yes*," "*Yes*," "*Yes*," for the foreign-born whites in answer to the same inquiries. If this were the case, the number able to speak English among the foreign-born whites 10 years of age and over in 1900 would be about the same as the number of literates, while the number unable to speak English would be close to the number of illiterates. Table VI seems to justify this suspicion in regard to carelessness of enumerators in the case of foreign-born whites. The number unable to speak English in 1910 is almost twice as great as the number of illiterates in 1910, and in 1890 the number unable to speak English exceeded the number of illiterates by 223,473.

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* Thirteenth Census, vol. 1, p. 1265.

TABLE VI

FOREIGN-BORN WHITES TEN YEARS OF AGE AND OVER ILLITERATE AND UNABLE TO SPEAK ENGLISH, 1890, 1900, AND 1910. (U. S. CENSUS, 1910, VOL. 1, PP. 1213, 1277.)

Year	Total foreign-born 10 years of age and over	Illiterates		Unable to speak English	
		Number	Per cent	Number	Per cent
1910	12,944,529	1,650,361	12.7	2,953,011	22.8
1900	10,014,256	1,287,135	12.9	1,217,280	12.2
1890	8,786,887	1,147,571	13.1	1,371,044	15.6

But in 1900 the reverse is shown, the number of illiterates exceeding by 69,855 the number of those unable to speak English. There seems to be no other explanation for the excess of illiterates over the number unable to speak English in 1900 than that the number of the latter was understated in the Twelfth Census. The proportion of illiterates in the total foreign-born population 10 years of age and over in 1910 was almost half that of the proportion unable to speak English. In 1890, 15.6 per cent of the foreign-born population could not speak English and 13.1 per cent were illiterates. In 1900 the respective proportions unable to speak English and illiterate in the foreign-born population 10 years of age and over were very nearly the same. Of the immigrants arriving in the United States the number unable to speak English at the time of arrival greatly exceeds the number of illiterates, which accounts for the greater numbers of illiterates in 1910 as compared with preceding decades. Immigration during the decade 1891–00, as shown in Table IV, more closely resembled in character the immigration during the decade 1901–10 than that during the decade 1881–90; consequently, the difference between the proportions of illiterates and of those unable to speak English in 1900 should be nearer the difference in 1910 than in 1890.

Thus analyzed, the data presented in Tables IV and V seem to warrant the conclusion that the number unable to speak English was understated in the Twelfth Census and that consequently no comparison can safely be attempted between the number unable to speak English in 1910 and in 1900.

V. FOREIGN-BORN UNABLE TO SPEAK ENGLISH, 1910

The arrangement of the schedule in 1900, referred to above, was changed so that the cause for the error which was apparently made in 1900 was removed in the census following. The table next presented (Table VII) shows the condition in respect to inability to speak English

TABLE VII

PER CENT OF FOREIGN-BORN WHITES 10 YEARS OF AGE AND OVER OF TOTAL WHITE POPULATION 10 YEARS OF AGE AND OVER; AND PER CENT OF FOREIGN-BORN WHITES 10 YEARS OF AGE AND OVER UNABLE TO SPEAK ENGLISH, OF FOREIGN-BORN WHITES, AND OF TOTAL WHITES 10 YEARS OF AGE AND OVER, BY STATES

State	Whites 10 years and over	Foreign-born whites 10 years and over	Foreign-born unable to speak English, 1910	Per cent foreign-born of total whites 10 and over	Per cent unable to speak English	
					of foreign-born	of total white
United States	64,262,348	12,944,529	2,953,011	20.2	22.8	4.6
Arizona	155,968	43,724	25,072	28.0	57.3	16.0
Texas	2,341,815	224,580	125,765	9.6	56.0	5.4
New Mexico	239,646	21,235	11,776	8.8	55.5	4.9
West Virginia	852,897	54,646	27,461	6.4	50.3	3.2
Florida	330,978	32,155	14,049	9.7	43.7	4.2
Pennsylvania	5,846,624	1,390,564	466,825	23.8	33.6	8.0
New Hampshire	353,638	92,976	26,783	26.3	28.8	7.8
Delaware	138,303	16,940	4,824	12.2	28.5	3.5
Ohio	3,754,837	579,274	163,722	15.4	28.3	4.4
Indiana	2,109,755	155,596	40,731	7.3	26.2	1.9
New Jersey	1,953,369	636,848	153,861	32.6	24.2	7.8
Wisconsin	1,827,311	502,591	120,665	27.5	24.0	6.6
Louisiana	688,126	50,333	11,547	7.3	22.9	1.7
Illinois	4,400,806	1,168,559	266,557	26.6	22.8	6.6
New York	7,294,978	2,634,578	597,012	36.1	22.7	8.2
Wyoming	115,561	26,381	5,970	22.8	22.6	5.2
North Dakota	424,184	150,451	33,491	35.4	22.3	7.9
Kansas	1,277,020	131,673	28,358	10.3	21.5	2.2
Rhode Island	432,152	171,904	36,961	39.8	21.5	8.6
Oklahoma	1,096,319	39,064	7,975	3.6	20.4	.7
Connecticut	888,428	318,780	64,201	35.9	20.1	7.2
Nevada	69,353	17,787	3,557	25.6	20.0	5.1
South Dakota	442,769	98,334	18,486	22.2	18.8	4.2
Maine	602,227	105,336	19,589	17.5	18.6	3.2
Colorado	630,856	123,026	22,610	19.5	18.4	3.6
Michigan	2,221,695	579,803	102,286	26.1	17.6	4.6
Vermont	287,682	47,654	8,342	16.6	17.5	2.9
Maryland	843,496	100,951	17,544	12.0	17.4	2.1
Nebraska	917,307	172,497	29,519	18.8	17.1	3.2
Missouri	2,246,215	223,573	37,747	9.1	16.9	1.5
Massachusetts	2,710,966	1,020,594	171,014	37.6	16.8	6.3
Minnesota	1,622,269	533,915	89,850	32.9	16.8	5.5
Arkansas	807,078	16,454	2,741	2.0	16.7	.3
Alabama	879,219	18,291	3,028	2.1	16.6	.3
Mississippi	565,329	9,046	1,491	1.6	16.5	.3
Virginia	1,039,879	25,639	3,983	2.5	15.5	.4
Montana	301,918	89,456	13,718	29.6	15.3	4.5
California	1,988,999	505,312	74,706	25.4	14.8	3.7
Idaho	248,440	39,619	5,805	15.9	14.7	2.3
Iowa	1,747,906	269,246	37,169	15.4	13.8	2.1
North Carolina	1,088,200	5,734	779	.5	13.6	(a)*
Oregon	554,272	100,759	13,531	18.2	13.4	2.4
Utah	273,752	61,840	8,129	22.6	13.1	3.0
Washington	928,039	234,928	25,568	25.3	10.9	3.8
Kentucky	1,512,616	39,571	3,816	2.6	9.6	.3
Tennessee	1,260,516	17,985	1,648	1.4	9.2	.1
South Carolina	494,097	5,911	447	1.2	7.6	(a)
Georgia	1,038,916	14,656	953	1.4	6.5	(a)
District of Columbia	199,124	23,755	1,349	11.9	5.7	.7

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* (a) Less than one-tenth of one per cent.

within the separate states in 1910. It will be seen that for the country as a whole the per cent of foreign-born whites 10 years of age and over unable to speak English was 22.8 per cent of the total foreign-born white population of that age group, and 4.6 per cent of the total white population 10 years of age and over. Thirteen states showed percentages unable to speak English above the percentage for the United States, varying from 57.3 per cent in Arizona to 22.9 per cent in Louisiana. The five states (Arizona to Florida) which show the largest proportions unable to speak English have 2.9 per cent of the total foreign-born whites* of the United States and 6.9 per cent of the total foreign-born unable to speak English in the country. The seventeen states (from Pennsylvania to Nevada) showing proportions of the foreign-born unable to speak English from one-fifth to about one-third, contain the greatest bulk of the foreign-born and of those unable to speak English. Table VIII shows the distribution of the foreign-born of the total white population and of those unable to speak English in the three groups of states. It will be seen (Table VII) that in the third group (from South Dakota to the District of Columbia) the proportions of those unable to speak English range from 18.4 per cent to as low as 5.7 per cent.

TABLE VIII

DISTRIBUTION OF THE TOTAL WHITE POPULATION AND OF THE FOREIGN-BORN WHITE POPULATION, 10 YEARS OF AGE AND OVER, AND OF THOSE UNABLE TO SPEAK ENGLISH, BY GROUPS OF STATES

	Arizona to Florida (5 states)	Pennsylvania to Nevada (17 states)	South Dakota to District of Columbia (26 states)	United States
Total white population 10 years of age and over	7,921,304	32,670,764	27,669,783	64,261,851
Total foreign-born whites 10 years of age and over	376,340	8,084,299	4,483,890	12,944,529
Total unable to speak English	204,123	2,033,040	715,848	2,953,011
Per cent of whites 10 years and over of total in U. S. 10 years and over	6.1	50.8	43.0	99.9
Per cent of foreign-born whites of total foreign-born whites in United States	2.9	62.4	34.6	99.9
Per cent unable to speak English of total unable to speak English in United States	6.9	68.8	24.2	99.9

It is seen from Table VII that in thirty-four states and in the District of Columbia the proportion of foreign-born unable to speak English is lower than for the country as a whole and that in Arizona, Texas, New Mexico, West Virginia, and Florida the proportions of non-English speaking are so much above the average for the United States as to present a separate problem.

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* Unless otherwise specified the terms *foreign-born whites, total white population,* and *white population* are here meant to include only those 10 years of age and over.

VI. CONCENTRATION OF FOREIGN-BORN NO HINDRANCE IN LEARNING TO SPEAK ENGLISH

From Table IX it will be seen that the states which show the greatest concentration of foreign-born do not show the highest proportions of foreign-born unable to speak English. In Rhode Island, for instance, 39.8 per cent of the total white population 10 years of age and over is foreign-born, but the proportion of foreign-born unable to speak English is only 21.5 per cent, which is somewhat below the average for the country. Massachusetts, with a high proportion of foreign-born, shows a comparatively low proportion unable to speak English. In New York, where 36.1 per cent of the total white population is foreign-born, the proportion unable to speak English is not quite so high as for the United States. On the other hand, it will be seen from Table VII that in some of the states which show low percentages of foreign-born in the total white population, the proportions unable to speak English are higher than for the states shown in Table IX. Omitting such extreme cases as Texas, New Mexico, West Virginia, and Florida, it will be seen that Delaware, Ohio, Indiana, and Louisiana show proportions unable to speak English above the average for the country. In Kansas and in Oklahoma, where the proportion of foreign-born of the total white population is low, the proportion unable to speak English

TABLE IX

PER CENT OF FOREIGN-BORN WHITES 10 YEARS OF AGE AND OVER OF TOTAL WHITE POPULATION 10 YEARS OF AGE AND OVER, AND PER CENT UNABLE TO SPEAK ENGLISH OF THE FOREIGN-BORN WHITES AND OF THE TOTAL WHITE POPULATION, FOR CERTAIN STATES

State	Per cent foreign-born of total population 10 years of age and over	Per cent foreign-born unable to speak English of foreign-born 10 years of age and over	Per cent foreign-born unable to speak English of total white population 10 years of age and over
Rhode Island	39.8	21.5	8.6
Massachusetts	37.6	16.8	6.3
New York	36.1	22.7	8.2
Connecticut	35.9	20.1	7.2
North Dakota	35.4	22.3	7.9
Minnesota	32.9	16.8	5.5
New Jersey	32.6	24.2	7.8
Montana	29.6	15.3	4.5
Arizona	28.0	57.3	16.0
Wisconsin	27.5	24.0	6.6
Illinois	26.6	22.8	6.6
New Hampshire	26.3	28.8	7.8
Michigan	26.1	17.6	4.6
Nevada	25.6	20.0	5.1
California	25.4	15.8	3.7
Washington	25.3	10.9	3.8
Pennsylvania	23.8	33.6	8.0
Wyoming	22.8	22.6	5.2
Utah	22.6	13.1	3.0
South Dakota	22.2	18.8	4.2
United States	20.2	22.8	4.6

is higher than in such states as Massachusetts, Connecticut, Montana, Michigan and others in which the proportions of foreign-born of the total white population are high. From these data it appears that the concentration of immigrants does not act as a hindrance in their learning to speak English, but, on the contrary, seems to have an effect in the opposite direction.

VII. INABILITY TO SPEAK ENGLISH GREATEST IN RURAL COMMUNITIES

The next table (Table X) shows that in rural communities the percentage of foreign-born unable to speak English is higher than it is in urban communities. Of the total foreign-born whites 10 years of age and over in urban communities, 21.9 per cent were non-English speaking, while of the total rural foreign-born population of that age the non-English speaking were 25.2 per cent. The proportion for each specified class of urban communities is lower in every case than it is for rural communities.

Of the foreign-born whites unable to speak English, 2,042,881, or 69.2 per cent, were living in urban communities, of which number 833,404, or 40.8 per cent, were living in cities of 500,000 inhabitants or more.

The fact that in urban communities the proportion unable to speak English is lower than in rural communities shows, as has already been pointed out (Tables VII and IX), that the concentration of foreign-born does not retard their learning to speak English, but on the contrary seems to have the opposite effect. This may be due to better educational facilities in the cities as well as to a greater association between older and newer immigrants in organizations or in industrial establishments, or to wider association generally between immigrants and natives in urban communities.

TABLE X

FOREIGN-BORN WHITES UNABLE TO SPEAK ENGLISH, BY CLASS OF COMMUNITY. (THIRTEENTH CENSUS, VOL. 1, P. 1273.)

Class of community	Foreign-born white population 10 years of age and over, 1910		
	Total	Unable to speak English	
		Number	Per cent
Total	12,944,529	2,953,011	22.8
Urban communities	9,331,994	2,042,881	21.9
Places of 2,500 to 25,000	2,093,984	498,955	23.8
Places of 25,000 to 500,000	3,499,863	710,522	20.3
Places of 500,000 and over	3,738,147	833,404	22.3
Rural communities	3,612,535	910,130	25.2

VIII. INABILITY TO SPEAK ENGLISH, BY SEX

The Thirteenth Census* shows that for the country as a whole there is but a slight difference between males and females—a difference of four-tenths of one per cent in favor of the females. In the North and the West the proportions for the females are lower than for the males, while in the South the reverse is true. In three of the nine geographic divisions, namely, New England, West North Central, and West South Central, the proportions of females unable to speak English are higher than of the males. In the other six divisions the males show higher proportions unable to speak English. Of the total foreign-born white population 21 years of age and over, 22 per cent were unable to speak English in 1910 as compared with 22.8 per cent of the foreign-born white population 10 years of age and over. The proportion of total foreign-born whites 21 years of age and over unable to speak English was the same for both sexes.†

IX. INABILITY TO SPEAK ENGLISH, BY AGE GROUPS

Table XI shows the proportions of those unable to speak English in each of the eight age groups for which data are available. It will be observed that the highest proportion of non-English speaking is found (with the exception of the group "age unknown") in the 20- to 24-age group.

TABLE XI

FOREIGN-BORN WHITES UNABLE TO SPEAK ENGLISH IN 1910, BY AGE GROUPS, BOTH SEXES. (COMPUTED FROM CENSUS 1910, VOL. 1, PP. 322, 324, 1281.)

Age group	Total	Unable to speak English	
		Number	Per cent
10 years and over	12,944,529	2,953,011	22.8
10–14 years	358,330	56,405	15.7
15–19 years	673,761	227,649	33.8
20–24 years	1,430,381	497,511	34.8
25–34 years	3,168,411	902,949	28.5
35–44 years	2,711,568	538,798	19.1
45–54 years	2,071,415	324,865	15.7
55–64 years	1,321,103	192,488	14.6
65 and over	1,183,349	201,709	17.0
Age unknown	26,211	10,637	40.6

It was shown in Table I that beginning with age 14 the proportions of foreign-born whites attending school are considerably smaller than of the native whites and that these proportions keep declining steadily and sharply to the age of 20, at which age only 3.0 per cent of the foreign-born whites were attending school in 1909–10. Table XI shows that the greatest proportions of those unable to speak English are found within the ages of 15 to 34. The higher proportions of inability to speak English found in these age groups are very probably due to the fact that most immigrants arrive at these ages and that very few of them attend school. The steady decline downward in the proportions of those unable to speak English from the age group 25 to 34 to the ages 65 and over is no doubt due to the fact that a large proportion of the immigrants of the more advanced ages have been in the country long enough to have learned to speak English without schooling. It seems certain that if our educational institutions could reach the foreign-born between the ages of 15 to 34 (or even 15 to 24) they would not only reduce the proportions unable to speak English within these age groups but they would at the same time, of course, reduce the proportions of non-English speaking in the higher age groups.

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* Thirteenth Census, vol. 1, p. 1271.

† Thirteenth Census, vol. 1, p. 1271.

The higher proportions of those unable to speak English at the ages of 65 and over are not significant for the reason that persons of that age do not generally participate actively in the life of the community.

X. SUMMARY OF CONCLUSIONS

The foregoing analysis of the data presented seems to warrant the following conclusions:

1. The problem of learning to speak English is one affecting only the first generation and about ninety per cent of our immigration.

2. The census data of 1900 on inability to speak English among the foreign-born are evidently inaccurate, and consequently no comparison can safely be attempted with these data.

3. The greatest number of those unable to speak English in 1910 is found in seventeen states (Tables VII and VIII, Pennsylvania to Nevada). Of the remaining thirty-one states, five (Arizona to Florida) show exceptionally high proportions of those unable to speak English. Within the remaining twenty-six states and the District of Columbia the proportions unable to speak English are comparatively low.

4. The states which show a very high proportion of foreign-born whites 10 years of age and over of the total white population of the same age group, or, in other words, the states which show great concentration of foreign-born do not show correspondingly high proportions of those unable to speak English, while on the other hand many states having a small ratio of foreign-born to the total population show higher proportions of those unable to speak English. Likewise, urban communities show lower proportions of those unable to speak English than do rural communities. It may be concluded, therefore, that concen-

tration of immigrants does not act as a deterrent in learning English, but seems to have an effect in the opposite direction.

5. The gradual decrease from the younger to the older age groups in the proportions of those unable to speak English, beginning with the ages 25 to 34, shows that a knowledge of spoken English comes naturally with increased length of residence in the country.

6. If effective measures could be taken to teach English to foreigners between the ages of 15 and 19, or between 15 and 24, the greatest number of non-English speaking would be reached and thereby the proportions of those unable to speak English would naturally be considerably reduced in the succeeding ages.

7. Exceptional socio-economic forces calling for special attention and study are in operation within the states showing very high proportions of non-English speaking foreign-born whites. (Table VIII.)

INDUSTRIAL CLASS ALIGNMENTS IN THE UNITED STATES

By Alvin H. Hansen, *University of Minnesota*

If all the urban wage-earners of the United States were to unite politically, would they constitute an overwhelming majority? What is the relative numerical strength of industrial wage-earners as compared to business proprietors and officials? What is the relative industrial and political strength, numerically, of the rural population? Under the existing industrial organization, how much room is there at the top? What opportunity is there for the average individual to rise to a position of comparative independence as proprietor, executive official, or professional person? In short, what proportion of the gainfully employed persons in the United States is compelled by the existing structure of industrial society to remain in the wage-earning class? Who is the "public" so far as industrial disputes are concerned, and how large is this class? In the conflicts that are forming on the basis of industrial class alignments, what is the maximum strength that the various groups may hope to muster?

The census data on occupations are not altogether satisfactory material upon which to base a conclusive answer to the above questions. The designation of occupations is not always sufficiently clear to make exact classification possible. In this respect the volume on occupations of the 1910 census is a considerable improvement over previous census reports on occupations. From this census the writer was able to classify 94 per cent of the gainfully employed persons. The censuses of earlier decades are not so clear in their designation of occupations, but it was possible to make a classification of about 91 per cent of the gainfully employed persons reported for the years 1900, 1890, 1880, and 1870. A study was also made of the reports on occupations for the years 1860 and 1850, with a view to presenting a continuous study from 1850 to 1910. The results for these two earlier periods were found, unfortunately, to be entirely unsatisfactory for purposes of comparison. There are two reasons for this: first, slaves were not included in these reports, and since they were largely devoted to agricultural pursuits the proportion of gainfully employed persons reported in agriculture was much too small; second, these two censuses report only the gainfully employed persons above the age of fifteen, while the succeeding censuses report all above the age of ten.

In two articles published in the *Journal of Political Economy*, Vol. 19, pp. 188–215; 309–337, Mr. Isaac A. Hourwich makes a classification of the gainfully employed persons for the years 1870–00. He derived his classification in part from the census returns on occupations and in part from the census of manufactures and the census of mines and quarries. The present writer derived his classification exclusively from the volume on occupations of the Twelfth Census and Volume IV of the Thirteenth Census. The classification adopted differs somewhat from that of Mr. Hourwich, and the larger groupings are on considerably different lines. This study further brings the material down through the 1910 census. The 1920 census will, of course, not be available for some time.

It was found feasible to group all gainfully employed persons as reported in the above mentioned census volumes into the following main classifications:

1. Farm Laborers
2. Farmers
3. Proprietors and Officials
4. Professional Class
5. Lower Salaried Employees
6. Servants
7. Industrial Wage-earners
8. Unclassified

The designation "Farm Laborers" includes members of the family working on the home farm and laborers working out. This differentiation is made, however, only in the two censuses of 1910 and 1900. In 1910 the "home" laborers constituted 53.9 per cent of all farm laborers, and in 1900, 53.7 per cent. It was assumed that approximately this ratio obtained in the earlier decades as well, and the number of "home" laborers was therefore estimated by taking 53.8 per cent of the total number of farm laborers. Fifty-four per cent of all farm laborers in 1900 were under 21 years of age. It thus appears that the laborers working on the home farm are children of farmers not yet of age, while the laborers working out are very largely adults.

"Farmers" includes farmers, planters, dairymen, stock raisers, herders, drovers, and feeders. For the year 1910, gardeners, florists, fruit growers, and nurserymen are also included. The latter groups were for the earlier periods relegated to the unclassified group because the reports for those years do not distinguish between proprietors and laborers. "Farmers" includes both farm owners who farm their own land and tenants. In 1880 about 75 per cent owned their land, while in 1910 only 63 per cent were owners of the land operated.

"Proprietors and Officials," as the designation is here used, includes manufacturers and officials; proprietors, officials, and managers; transportation officials and superintendents; mining operators, officials, and managers; mechanical engineers; officials of banks and other companies; bankers and brokers; real estate and insurance agents; commercial travelers; merchants and dealers at retail and wholesale; auctioneers; undertakers; jewellers (not workers); livery stable keepers; garage keepers and managers; proprietors and managers of transfer companies; hucksters and peddlers; hunters and trappers: saloon keepers; restaurant keepers, hotel keepers; and boarding-house keepers.

The "Professional Class," for the purpose of this classification, is used in a broad sense and includes not merely the groups regularly referred to as professional, but also untrained nurses and such public service groups as detectives; sheriffs; marshals; policemen; officials and inspectors of municipalities, counties, states, and the federal government; soldiers, sailors, and marines; and life-savers.

The "Lower Salaried Employees" class includes foremen and overseers, clerks and copyists, stenographers and typewriters, bookkeepers and accountants, agents and collectors, inspectors and samplers, demonstrators, sales agents, ticket and station agents, express agents, baggage men and freight agents, mail carriers, chauffeurs, housekeepers and stewards.

The "Unclassified" group includes, in part, groups referred to in the census reports under some indefinite designation such as "other pursuits." Much the greater portion of this group, however, is composed of occupations for which the designation does not distinguish between proprietor and workmen, such as watchmaker, milliner, launderer, shoemaker, brewer, distiller. From 60 to 80 per cent is composed of master and journeymen trades, in which it is impossible to distinguish between proprietor and workman, such as barbers, bakers, blacksmiths, butchers, painters, paperhangers, plasterers, plumbers, and tailors. It is to be noted, therefore, that this "Unclassified" group would, if accurate classification were possible, fall very largely in either the proprietor class or the industrial wage-earning class. In all probability the proportion of entrepreneurs in this unclassified group is somewhat greater than the ratio obtaining between the designated proprietor and official class and the industrial wage-earning class. Especially is this true of the earlier decades for the reason that specialization and large scale production had not yet fully developed. For the same reason the occupation designations prior to 1910 necessarily distinguish less clearly among employers, employees, and persons working for themselves. Not only is the unclassified group larger, therefore, in the earlier periods, but—and perhaps this is of still greater importance—the proportion of entrepreneurs and proprietors to wage-earners is also larger in the earlier decades. The net effect is that the number given in the proprietor and official group in the following table is something of an understatement, particularly for the earlier census periods.

"Industrial wage-earners" includes all wage-earners except servants, farm laborers, and that portion of the wage-earning class which falls for lack of clear census designation into the unclassified group.

The number of gainfully employed persons falling into each of the classifications just described is given in Table I. The percentage distribution is given in Table II. It will be noted that the proprietor and official, professional, salaried, and wage-earning groups have steadily become more important relatively. Servants have declined in relative numerical importance. Farmers held their own until after 1890 and then upon the disappearance of free land rapidly declined. The percentage of farm laborers decreased rapidly until 1890, which indicates that while free land could be obtained a larger and larger proportion of our agricultural population were becoming independent farmers. Since 1890 the proportion of the rural population that are farm laborers has been rapidly increasing. There also appears to be some increase in the farm labor class as compared to the total gainfully employed population. However, because of inadequate instructions to enumerators, earlier censuses do not give so complete returns for farm laborers as does the 1910 census.* From 1900 to 1910 there was probably a slight decrease (instead of the apparent slight increase indicated) in the proportion of farm labor to the total gainfully employed population.

TABLE I

	1870	1880	1890	1900	1910
Farm laborers	2,885,996	3,323,876	3,004,061	4,410,877	6,143,998
Farmers	3,000,229	4,282,074	5,370,181	5,770,738	6,229,161
Proprietors and officials	581,378	807,049	1,347,329	1,811,715	2,879,023
Professional	414,708	666,338	1,114,507	1,565,686	2,074,792
Lower salaried	309,413	529,473	965,852	1,329,928	2,393,620
Servants	975,734	1,075,655	1,454,791	1,453,677	1,572,225
Industrial wage-earners	3,328,351	5,286,829	7,360,442	10,263,569	14,556,979
Unclassified	1,010,114	1,420,795	2,118,498	2,467,043	2,317,538
Total	12,505,923	17,392,099	22,735,661	29,073,233	38,167,336

TABLE II

	1870	1880	1890	1900	1910
Farm laborers	23.1	19.1	13.2	15.2	16.1
Farmers	24.0	24.6	23.6	19.8	16.3
Proprietors and officials	4.6	4.6	5.9	6.2	7.5
Professional	3.3	3.8	4.9	5.4	5.4
Lower salaried	2.5	3.0	4.3	4.6	6.3
Servants	7.8	6.2	6.4	5.0	4.1
Industrial wage-earners	26.6	30.4	32.4	35.3	38.2
Unclassified	8.1	8.2	9.3	8.5	6.0

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* Census of 1910, Vol. IV., pp. 26–29.

INCREASING INDUSTRIALIZATION

The increasing industrialization of the country and the relatively declining importance of agriculture are indicated in Table III. Here the gainfully employed population is grouped under three categories, if we omit from our consideration that portion designated as unclassified. The first group includes the proprietors and officials, the lower salaried and professional classes. It is the "white collar" urban population, not all even moderately well circumstanced, but constituting on the whole the middle and upper urban class. The second group is composed of all gainfully employed agriculturalists—the farmers, tenants, and farm laborers. This group represents what remains of the old type of American individualists. The industrious and frugal tenant in most cases still becomes in time, though with increasing difficulty, a farm owner. The farm laborer, with the exception of the relatively small migratory class, hopes to save enough to set up as an independent tenant. Getting on is still largely a matter of individual push and initiative. True, the problems of organization and control of markets loom larger and larger, but the road to independence and advancement is still open even though it is not so easy and broad as before. The third class is composed of urban workers—the industrial wage-earners and servants. They are for the most part shut up in the wage system. If they are to better their condition they must do so not by way of escape to something else, but by improvement of their lot as wage-workers.

The farming group is being increasingly cut into on one side by the business, salaried and professional group, and on the other side by the industrial wage-earners. The relative growth of the former group would seem to be a healthy sign, but it should be noted that a large part of this growth, nearly a half in fact, is due to the rapid increase of the lower salaried employees whose position is certainly not very desirable. Further than that, not only is the rural group declining in relative importance, but within that group itself the opportunities for advancement are narrowing down, as has already been shown, because of the encroachment of tenants and farm laborers upon the farm owning class.

TABLE III.

	1870	1880	1890	1900	1910
Urban upper and middle class	10.4	11.4	15.1	16.2	19.2
Rural group	47.1	43.7	36.8	35.0	32.4
Urban workers	34.4	36.6	38.8	40.3	42.3
Unclassified	8.1	8.2	9.3	8.5	6.0

INDUSTRIAL INDEPENDENCE

Yet in spite of these tendencies it is surprising to find what a large proportion of the gainfully employed population are business men, farmers, and professional men. Table IV shows that in 1910 about 38 per cent still belonged to this independent class. Disregarding again the unclassified, the gainfully employed population is here placed in two groups. One group is composed of the business and professional classes, farmers and the children of farmers. The latter, of course, expect to become independent farmers upon reaching maturity, and hence, while listed as laborers, from the standpoint of this classification they may properly be classed with the farmers. This, then, is the industrially independent group, independent not so much from the standpoint of income as from the standpoint of being one's own boss.

The second group is composed of the rural and industrial wage-earners and the lower salaried employees. No doubt some of this group receive incomes in excess of many farmers, and even of professional and business men. But their outlook is different because of their place in the industrial system. The old type of American industrial ideals, based on individual proprietorship and industrial independence, may be expected to hold sway—so far as the former group is concerned. But the old slogans do not fit the life of the latter group, and the old appeals cannot be expected in the long run to be successful. This is by no means saying that it is a homogeneous group or that any one type of appeal can be made to all.

TABLE IV

	1870	1880	1890	1900	1910
Proprietary and independent class	44.3	43.3	41.5	39.6	37.9
Rural and urban working class	47.6	48.4	49.2	51.9	56.0
Unclassified	8.1	8.2	9.3	8.5	6.0

LABOR, CAPITAL, AND THE PUBLIC

The class conflicts that are forming on the basis of the growing class alignments are many and varied, but the one which looms up in overwhelming importance is the struggle between labor and capital. In connection with this struggle the neutral party, the so-called public, is frequently referred to. It is admittedly difficult to define this group in a manner that will give general satisfaction. Nevertheless, an effort will be made to determine which of the various groups listed in Table I may properly be placed in each of the three groups, "labor," "capital," and the "public."

To answer this question a merely mechanical classification on the basis of industrial status will not suffice. The classification to be realistic must be based to a certain extent on industrial psychology. As Hoxie put it, those "who feel that their interests are identical with those of the employers, whose motives, habits of thought, social attitudes and sympathies are in harmony with the mass of employers belong to the employing class." Such a basis of classification, however, must not be used without due consideration of the industrial status of the group concerned. We must consider not only the conscious alignments that have actually materialized, but also the probable field of alignment in the not far distant future. Both industrial status and industrial psychology must be considered.

The entire group here designated as industrial wage-earners may, on the whole, safely be placed in the class referred to above under the title of "labor." It is true that many in this group have not as yet developed any marked class consciousness, and the status of some of them is of such a nature that they are likely to continue to partake to some extent of the psychology of their employers. But for the overwhelming majority this group constitutes a fertile field for working-class agitation and movements. None of the other groups here given can be placed in toto in the "labor" class. Most farm laborers still expect to rise out of the wage-earning status and therefore are lined up with the farmers as far as their industrial psychology is concerned rather than with the wage-earners. The servant class, although not having the prospect of independence that farm laborers have, cannot as yet be properly placed in the "labor" class because of personal relationship with their employers on the one hand and isolation from their fellows on the other. The lower salaried employees, although sometimes worse off than the higher paid industrial wage-earners, still take their cue from their employers and imagine themselves to be a part of the "business" world. There are indications that the above statement no longer holds for England, but for the United States, as far as the industrial conflict is concerned, this group may properly be placed with the proprietors and officials in the class referred to under the designation "capital."

The term "public," then, comprises all those who are not directly involved in the industrial conflict. Farmers and farm laborers pretty clearly belong to this class. The servant class is more doubtful. For reasons given above this group cannot properly be classed with "labor." Nor are they by occupation and outlook tied to the business class in the way that the small salaried employees are. It seems, therefore, best to class them with the public. The professional class is also somewhat doubtful. It is certainly true that a large part of the professional class have the social attitudes and sympathies of the employing class. On the other hand a considerable body of clergymen, physicians, nurses, and teachers find their sympathies leaning toward labor. At any rate, as far as their industrial status is concerned, they are for the most part in a position to take a fairly neutral point of view. I have therefore included them with the "public" group.

The unclassified group, if it could be distributed, would for the most part swell the ranks of "labor" on the one side and "capital" on the other, probably, in about the same proportion as given below.

What then is the relative strength of "capital," "labor" and the "public?" One sees the statement time and again that labor represents the *overwhelming* majority. From Table V it is clear that on the basis of any realistic classification "labor" is not even a majority. It also appears that the numerical strength of "capital" as compared to "labor" is much larger than is commonly supposed. The ratio is approximately one to three. So far as the numerical influence politically is concerned even this ratio is deceiving for the reason that relatively few of the "capital" group are non-voters, while a very large proportion of the "labor" class are disenfranchised because of being minors, aliens, or negroes. Nearly one-fifth are minors, nearly 4 per cent are adult negroes, and a large proportion of the foreign-born wage-earners are not yet naturalized. On the other hand, in the "capital" class, the only group that includes very many minors is the lower salaried class, and even in this group the minors constitute less than 16 per cent. Negroes and aliens do not cut much of a figure in the "capital" class.

It is clear that the "public" in 1870 constituted a good sized majority. Since 1890 this majority has, however, rapidly dwindled until in 1910, though still larger than the labor group, it constituted only 42 per cent of the total gainfully employed population. Besides, this group contains a great many non-voting negroes and minors under voting age and some aliens. About 25 per cent of the rural gainfully employed persons are under 21 years of age and about 10 per cent are adult male negroes. There are also the foreign-born agriculturalists who are not yet naturalized. Of the servant class about 30 per cent are minors, and about 22 per cent adult negroes. Twenty-five per cent are of foreign birth and a very large proportion of these are not naturalized. As regards the professional class, about 10 per cent are minors. Most of the adult negroes in this group (about 4 per cent) no doubt have the suffrage. It is therefore clear that the "public" and "labor" groups suffer very much more in the proportion of their non-voters than the capital group.

TABLE V

	1870	1880	1890	1900	1910
Capital	7.1	7.7	10.2	10.8	13.8
Labor	26.6	30.4	32.4	35.3	38.2
Public	58.2	53.7	48.1	45.4	41.9
Unclassified	8.1	8.2	9.3	8.5	6.0

METHODS OF DEVELOPING AN INDEX OF COLLECTION CONDITIONS

By W. H. Steiner, *Federal Reserve Board*

I

One of the most important problems which confronts the individual business enterprise is that of determining the status of its collections. In addition to determining the terms upon which it will sell, and checking the credit of the individuals and enterprises to which it sells, it must also take account of the degree of promptness with which payments are made to it by these trade debtors for the merchandise which they have purchased. In other words, it must consider the relation which actual collections bear to the terms upon which the goods are nominally sold. Not only, however, is the individual enterprise interested in its own experience, but it is interested as well in the general experience in its particular line of business and in its particular territory, while in addition it must consider, though perhaps somewhat less immediately, the general situation relative to collection conditions which prevails among business enterprises as a whole and in the country at large.

The latter problem, however, is of interest also to the student of general business conditions. It is well known that collections fluctuate with general business conditions. This variation may occur in one of several ways. To illustrate, let us consider as typical terms upon which merchandise is sold, 1 per cent 10 days, net 30 days; that is, a cash discount of 1 per cent is permitted for payment within 10 days from date to invoice, while in the event that the buyer does not elect to take the cash discount, the bill is due net at the close of 30 days after date of invoice. When funds are readily obtained by the purchaser, either through prompt payment made to him by those to whom he sells his merchandise or through borrowing direct from his bank, he will elect to take the cash discount. The discount in the illustration which we have taken will be roughly at the rate of 18 per cent per annum, while if he borrows, the cost of the funds to him in general will be merely 6 per cent per annum, or less in certain cases. In other words, when business conditions are "good," there in general will be a high percentage of accounts which take the cash discount. The reverse will be the case when "money" is tight and bank reserves decline and interest rates rise, so that funds either become more difficult to obtain, or borrowing to take the cash discount at least becomes less profitable through a narrowing in the margin between the interest rate and the discount, while at the same time the purchaser's own collections are slower. In addition, at such times, the percentage of accounts which are not paid within the net period, but which instead run past due, will increase. In certain cases an extension of additional time may be requested, or a note running 30 days or longer may be tendered at the expiration of the original net period. Both of these forms will be found more frequently at such times. The relative extent to which each occurs will vary from industry to industry. Assuming an ordinary cash discount sufficiently large to be attractive where the bulk of the accounts sold are large well-rated firms, the regular percentage of accounts taking the cash discount will be large, and the change in general business conditions will be reflected principally in the decrease in the percentage of cash discounters. Where the reverse is the case, the change will be reflected chiefly in the percentage of past due accounts.

It will be observed that we have spoken of collections as fluctuating with general business conditions, according as the latter are "good" or "bad." Applying the modern theory of the business cycle, it would appear, however, that the change in conditions would already become apparent toward the close of the period of prosperity, as a "credit pinch" developed. But the exact relation of collections to the course of the business cycle is extremely difficult to ascertain. The chief obstacle lies in the difficulty of obtaining definite statistical data relative to collections. This in large part is due to the fact that no standard device exists for measuring collections, and various methods are thus employed at the present time. The methods in fact vary to some extent from industry to industry and are largely devised to meet the credit conditions peculiar to the industry in question. The statistical problem is chiefly one of the unit to be employed. What shall be taken to show the status of collections? All other aspects of the question are subordinate to this. It will be evident from the previous paragraph that the task is by no means simple and that numerous difficulties arise. In particular, credit conditions and terms on which merchandise is sold are by no means homogeneous, but vary considerably from industry to industry. In addition to the difficulty experienced in developing an index for a given industry, there then exists a further difficulty in attempting to show the general status of collections throughout our industrial life as a whole. The simplest approach will be to consider the various methods by which the individual business house may attempt to measure the status of its collections, and to indicate the suitability of the several methods under different types of terms on which merchandise is sold. To these methods we shall now direct our attention.

II

An ideal method of measuring the status of collections would appear to be through the use of an absolute collection percentage. Assuming that a month be the period of time chosen, there would be calculated each month *the percentage which the amount actually collected is of the amount which should have been collected.* Perfect collections would be indicated by 100 per cent and the actual percentages shown would range between the limits of 0 and 100. The use of this plan would involve ascertainment of a method of calculating both the numerator and denominator of the fraction employed to compute the percentage. Serious difficulties arise in connection with the denominator. Exactly what is the "amount which should have been collected?" It might appear that the test would lie in payment of accounts according to terms. But where a cash discount system prevails, if, to take the two extreme cases, on the one hand, all accounts are discounted, or on the other hand, all accounts are paid only at the expiration of the net period, payment in both cases is made according to terms. Yet in the second case collections are decidedly slower, and in industries in which in general a high percentage of accounts is discounted, the slowing up of collections will be found largely in this form. To take cognizance of this fact, it would be necessary to employ an approximation, shortening the average time represented by the net terms to take account of the customary proportion of accounts discounted. Payment of all accounts within that period would then be represented by 100 per cent.

One point stands out in this discussion. We have considered merely the proportion of accounts paid within a given period. Instead, we must take cognizance also of the time which is actually taken for payment. Not only is this the case for accounts paid at or prior to the expiration of the net period, but the time taken for the payment of delinquent accounts is also of significance, yet we have not considered it at all in the above discussion.

A second ideal method, supplementary, however, to the first, would then appear of calculating an absolute collection percentage. There would be calculated each month the *percentage which the average actual number of days in which accounts were paid was of the average actual number of days time on which the goods were originally sold.* In this case the denominator would again cause difficulty. Approximation alone would be possible, the average time represented by the net terms being shortened in the manner indicated above. To employ a specific illustration, assuming that the average length of terms computed in the manner just indicated was 20.086 days, the fraction employed in obtaining the collection percentage might read as follows:

$$\frac{250{,}000\times 10+200{,}000\times 15+500{,}000\times 30+50{,}000\times 40}{1{,}000{,}000\times 20.086}.$$

Assuming that the methodology was thus determined, it would be possible to calculate these percentages. To do so, however, would entail considerable additional expense and labor, as it would be necessary to trace each individual sale and to keep specific records for this purpose alone. Let us, therefore, examine the data which are contained in the records of the individual enterprise relating to its ordinary operations. Fundamentally, the data available represent (1) collections during the period, (2) outstandings, that is, accounts receivable on the books, at the opening and close of the period; and (3) sales during the period. But each of these in fact must be further resolved into several constituent elements. Collections are of four kinds: (1) amounts paid by those taking the cash discount, either within or without the cash discount period; (2) amounts paid prior to the expiration of the net period, that is, "anticipations" of the latter; (3) amounts paid at the expiration of the net period, and (4) amounts paid after the close of the original net period. Outstandings are either (1) current, that is, not yet due, or (2) past due. A further classification of these according to month when due and age, respectively, would appear desirable. If outstandings and collections be compared, the situation for a given month, such as September, would be as follows:

Outstandings on September 1	Collections during September
Past due	Collections against old past due accounts
Current, due net in September	Collections of current items at close of net Collections of current items after close of net Anticipations of current items
Due net in October, etc.	Discounts and anticipations of accounts due net in October and subsequent months Discounts and anticipations of accounts representing September sales

Where sales are employed as the norm, it would be necessary to consider the length of the net terms, and in particular to eliminate accounts bearing a season dating. A cruder measure in general would appear to be afforded than by the use of outstandings.

In fact, it would appear possible to obtain a substantially accurate percentage only where proximo or e.o.m. terms are employed, and for all the accounts, not merely for active accounts. In such cases all sales made during a given month, and shipped prior say to the 25th, are due (or subject to discount) on a specified date of the following month, most frequently the 10th. The outstandings at the close of the month, which are due on the 10th, afford an indication of the amount which should be received. Where, however, a large proportion of the accounts are paid only at the expiration of the net period, the figure will show merely the percentage of accounts taking the discount, and were it desired to supplement it, adjustment would be necessary, in which case the problems arising are similar to those indicated above. On the other hand, in industries in which the great majority of accounts will be paid by the 10th proximo, the method is of considerable value. It in fact is employed by the larger rubber companies in following the status of their collections from month to month, in particular for tires. In the latter industry terms in general are 5 per cent 10th proximo, 75 to 85 per cent of accounts of leading manufacturers are discounted, and a period within which accounts are due net is frequently not specified. Eliminating for ordinary months accounts which bear the spring dating, the outstandings at the close of the month may be taken as a norm. For comparison herewith, there is taken either the amount of these outstandings which have not been paid by a later date, such as the 15th or 30th, 5 and 20 days "grace" respectively being allowed in these methods, or there may be taken the collections which are made up to this later date. It is customary also to analyze further the outstandings at the close of the month. Separation is made according to age, those which are current, 30 days old, 60 days old, and 90 days old and over generally being distinguished. In many cases, of course, other classes of rubber goods are handled, and these often are not separated, what is termed by one company "a collectible" trial balance, for example, being figured in order to show the accounts on which they are actively working during the next 30-day period. Collections in the industry are largely made by credit managers at the branch houses, who each month report the data outlined above, as well as the condition of selected individual accounts, to the principal office which in this manner keeps informed as to the collection situation. Due to the peculiar terms employed in the industry, it is thus possible to follow the status of collections with substantial accuracy.

A possible application of this method is suggested in the case of highly seasonal industries in which season datings, affording annual or semi-annual settlement dates, are found. Men's clothing to some extent falls in this category, also manufacturing of fur. A similar situation prevails in the case of the agricultural sections, such as, for example, the Northwest, where October 1 is the "big pay day." A valuable indication would be afforded in such industries and sections by a consideration merely of the proportion of the amounts due at that time which was paid, no definite data for other periods of the year being obtained.

III

In industries in which proximo terms are either employed to a limited extent only or not at all, the ideal methods outlined above serve merely as guides and other more arbitrary and at the same time cruder methods are necessary. These in general are of two kinds. On the one hand, effort is made to arrive at what is a rough approximation to the denominator in the fraction considered above, and with the basis of expectancy thus obtained, there is compared a numerator representing collections made. As will be indicated presently, both numerator and denominator may be calculated in several ways. By this means, an expression is obtained for the flow of payments in relation to volume of business done. The second method consists of a *division of outstandings on a given date into current* (*that is, not yet due*) *and overdue.* In general the latter item is used in this manner only in the construction of an index, and is not compared with other items. It is not usually analyzed further by business houses according to age or length of time overdue, although a period of grace may be provided, accounts 30 days or more overdue, for example, merely being considered. The amount of accounts overdue is then expressed as a percentage of total outstandings on the given date. This method is frequently employed to supplement an index of the first mentioned description. Although of a simple nature, it may be very expressive. The decided decline in collections which many manufacturers of men's clothing have experienced this year is well illustrated by figures of the above description prepared by a leading manufacturer, which show that 82 per cent of his outstandings on June 30 were more than 30 days old, as against only 23 per cent on April 1. An interesting variation of the method is employed by another leading manufacturer who divides total outstandings at the close of the month into those originating (a) in the season previous to that just passed, (b) in the season just passed, and (c) in the present season. The percentage which each is of the total outstandings on that date is then calculated. Seasons, of course, change every six months.

There is, however, a danger that, used by itself, this method may serve rather as a record of past events, which are clearly perceived when passed in review, than as an effective record of the present situation and one which promptly calls the attention of the observer to the changes which are occurring at the time. But this may probably be held also in greater or lesser degree against any single index which may be constructed. It, however, points the way to the first test that any index which is developed must face. The index must give a prompt and a fairly accurate reflection of the collection situation, meaning by the latter requirement merely that the change which occurs in the index shall vary roughly in magnitude with the actual change which occurs in the collection situation. This requisite may be summed up rather roughly in the term "sensitiveness." But this test implies also that, second, the index include a proper basis of comparison or expectancy, and that this basis be not susceptible to purely extraneous influences, such as an increased volume of business which does not immediately affect the actual collection situation. Assuming that these general criteria are satisfied, the index chosen must be adapted to the credit conditions prevailing in the industry in question, in particular the terms of sale and the percentage of accounts which are discounted instead of being paid only at the expiration of the net period. Considered alone, the analysis of outstandings on a given date is of value rather in industries in which the greater proportion of accounts are not discounted, or in which net terms exclusively prevail. In industries in which the reverse is the case, the method serves instead basically as a supplementary device to take cognizance of the situation with respect to the accounts which are not discounted.

In industries of this description, an index of the first type is desirable. Several methods exist of constructing this type of index, and they consist largely of varying combinations of the several items enumerated above as supplying the working tools in actual practice, namely, sales, collections, and outstandings. Neglecting minor variations, either sales or outstandings may be taken as the basis of expectancy. With the item chosen, the collections made are then compared, or, where sales are employed, the same result may be indirectly obtained through the use of the outstandings at some later date. Let us consider at somewhat greater length typical examples of each of these two forms.

(1) *Calculation of the Percentage Which Outstandings on the First of the Month Are of the Previous Month's Sales.* The percentage may be stated, for example, either as of July 1, or for June, and both forms are in use. It is the recognized method employed by wholesale groc-

ers. About twelve state or territorial associations regularly obtain such reports each month from part of their membership, and their preparation reflects the widespread interest in the industry during the last few years in closer collections. Collection of all accounts within 30 days would be represented by a percentage of 100. As it would appear that on the whole approximately half the accounts of wholesale grocers are discounted, a shortening of the time would seem to be called for, but against this may be roughly set off active accounts on which proximo terms are granted, and the figure of 30 days may thus be retained. The percentage obtained may easily be converted into a figure representing the number of days' business outstanding, or, as sometimes phrased, the number of days in which accounts are collected. The latter figures, however, are employed comparatively seldom as compared with the percentage of outstandings. Another variation that has been employed by one wholesale grocers' association is the comparison with sales during a given month of collections during that month, instead of outstandings on the first of the following month. With this method, direct instead of indirect measurement of the flow of collections or rapidity of credit turnover is made. It may be noted that where longer terms are in use, sales during a previous month may be employed in order to give an approximate basis of expectancy, or else the amount of charges (representing shipments) may be employed. In such cases, moreover, collections rather than outstandings in general will be employed for purposes of comparison, and the method is in fact employed by a number of shoe wholesalers.

Prevailing wholesale grocery terms on the general line (excluding special items billed separately) are 1 per cent 10 days, net 30 days, one month's sales being due net during the following month, although proximo terms are also frequent on active accounts. The method is thus better adapted to that industry than to one in which longer terms prevail. Outstandings, aside from old overdue accounts, consist merely of amounts due net during the month, and do not represent a heterogeneous mass due net in any one of several months to come. But sales do not in all cases provide a fair basis of expectancy. This is particularly noticeable at seasons of the year when retailers purchase heavily, the percentages decreasing in consequence of the increase in the denominator. Moreover, in contrast to the situation which prevails where outstandings on a given date merely are analyzed over a period of time, the percentages of outstandings shown are affected by a shortening of terms, and this influence, as well as closer collections, has been present in the general decrease during the past few years in the percentages shown by wholesale grocers. But on the other hand this shortening of terms merely reflects the changes in progress in general business conditions.

One further question arises in connection with the construction of an index of this description. While in general no specific definition of the terms "sales" and "outstandings" is given, in the case of one association total outstandings are requested, no matter how represented, whether by note, or secured by mortgage, or otherwise. This raises the problem of the extent to which the percentage should be raised by including old past due accounts which such settlements will represent, and how far it should be kept "fresh" to depict the current situation. The question of the legitimacy of including cash sales has also been raised, inasmuch as such sales may largely represent intergrocer transactions, and thus do not enter into a true reflection of collections made by wholesale grocers of retailers' accounts with them.

(2) *Calculation of the Percentage of Collections During the Month to Outstandings on the First of the Month.* This method appears to be in considerable use among wholesale dry goods houses. Inasmuch as the regular terms on the general line in the industry are 2 per cent 10 days, 60 days extra, with anticipation permitted at the rate of 6 per cent per annum, making the discount for cash 3 per cent 10 days, while certain items also bear special terms, the method possesses at once certain elements of both strength and weakness. On the one hand, collection figures for any given month must have a wider basis of expectancy than is afforded by any single month's sales, and from this point of view, outstandings are probably the most satisfactory type of date. But they are subject to the influence of a changed volume of business, and where the industry, in particular in the West, is decidedly seasonal, datings, in general April 1 and October 1 on the general line, have been customary. In fact, certain houses state specifically that no value is attached to month to month comparisons, but that comparison alone is made with the same month of the previous year. Over a period of time, this type of index shows the influence of change in terms, but, as remarked above, this change in terms itself reflects the change in business conditions. Variation of the method is reported by one wholesale drygoods house, which adds to outstandings on the first of the month, both due and past due, the collections during the month, in order to obtain the basis of expectancy, and then compares collections therewith. Another house instead adds the charges during the month to the outstandings on the first of the month and compares the collections with this sum. In both cases, the thought is to include a basis of expectancy for that part of the present month's sales which is discounted and which would not be included in the outstandings on the first of the month.

The general method of comparing collections with outstandings is also employed to some extent by manufacturers of men's clothing. This line, however, is of a decidedly seasonal nature, season settlement terms, in general June and December, still largely prevailing, although within the last few years a number of houses have shortened terms or eliminated datings. The device then will be of value rather as the monthly changes in outstandings are considered in relation to the monthly changes in amounts collected, due allowance being made for season settlement dates, and the course of both items is compared with previous years. In so doing we abandon the plan of construction of a specific index, and consider instead changes in the actual items themselves. It will be observed that in the general method of comparing outstandings and collections, we in fact depart in considerable measure from the conception of finding an absolute basis of expectancy and adopt instead the thought of the relation of the flow of payments to non-payments.

There is also a further variation of this general method. The same principle may be applied as in the case where outstandings are analyzed into those which are current and those which are past due. In the present case, collections during the month may be compared with the outstandings at the close of the month, the sum of the two in fact affording a rough basis of expectancy.

In seasonal industries, cumulative percentages are frequently calculated for the current season, either in place of or supplementary to the monthly percentages. Sales and collections are most frequently employed, although the average of the outstandings at the close of each month to date may also be used in place of sales.

IV

In the construction of an index in this manner for a given industry, it is necessary for a central agency to obtain data from the individual houses and to combine the individual returns and prepare composite figures. Where returns are made in percentage form by the individual house, a method of weighting should be employed in order to assign approximately the proper degree of importance to the figure from each house. But this in fact is not done by any of the state and territorial wholesale grocers' associations, which are perhaps the most prominent organizations preparing such reports at the present time. In addition, the number and identity of the reporting firms varies somewhat from month to month. Additional importance is to be ascribed to lack of weighting because of the fact that the figures of the individual houses vary greatly, the extreme high and low percentages in the California report (covering 29 houses) for August 1, 1920, e. g., being 63.0 and 135.0, and the average for the state 100.2 per cent. The figures of each individual house are generally shown (though no names are given) and in certain cases figures of the same house for two months are placed opposite each other for purpose of comparison. At the bottom of the sheet is given the unweighted average calculated from the actual returns given above. Inasmuch as the operations of wholesale grocers frequently cover only a relative restricted territory, no question arises of the separation of accounts according to the territory in which located. In other industries, however, in which the business is perhaps even of a nation-wide character, separation of accounts according to territory is manifestly desirable. But in many cases business houses are unable to make the separation as the ledgers are kept alphabetically, or else the names of the states are arranged alphabetically. This is the case with some of the largest firms in the country at the present time, conspicuous examples which the writer recalls being a leading shoe manufacturer and a leading textile commission house.

The problem next arises of interpreting such data. This is complicated by the fact that in many industries, as already remarked above, such as wholesaling of groceries, a strongly marked secular trend is shown during recent years as the result of the existence of a sellers' market. Reports of wholesale grocers have had as one of their primary purposes to afford an indication of the extent to which closer collections were being made and terms were being shortened.* Moreover, the actual percentages on the whole show a marked seasonal change, more noticeable again since the close of the war, during which the tendency was somewhat submerged, and allowance must be made for this. In addition, choice of the base period is necessary. The problems in this connection, however, are substantially similar to those presented by any indices of business conditions and need not be considered here.

So much for the construction of an index for a given industry. For an understanding of general business conditions, the problem next arises of selection of industries which will either best anticipate (as has been claimed for certain wholesale price index numbers) or best depict conditions. In the construction of an index of general collection conditions, the method of sampling must be employed and certain industries alone considered, whether the final index consists merely of a series of indices reflecting conditions in each of the several industries, or whether these several indices be combined into one composite number. In short, the problem which confronts us is as to which industries are most sensitive or most representative. This involves selection from among the several stages of the economic process, as well as selection from among the various classes of commodities. On the one hand, it would appear that enterprises selling the retailer would first experience a decline in collections, rather than enterprises selling the wholesaler, while on the other hand it would appear that collections in lines handling luxuries rather than necessities would likewise first show a decline. An added consideration would of course be the average size of the purchasing firm, which is partly covered in the division of the economic process into stages. Finally, terms in the industry should be fairly standardized, although they of course should not be extremely short, such as two weeks or less. Although certain guiding principles may be laid down, the question cannot be decided *à priori*, but requires instead an empirical approach. Only when data are available for various industries will it be possible to make a firmly grounded decision.

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*Reference may be made to the addresses and articles of Mr. F. C. Letts, President of the Western Grocer Company, Chicago.

V

We have considered thus far construction of an index of collection conditions through special reports relative to collections furnished periodically by business houses to a central agency which compiles the composite figures, but the problem may be approached in another manner. The principal type of credit exchange bureau has as its function the furnishing of reports on the credit standing of accounts which the subscribers or members sell. Upon inquiry by one subscriber, a request for data is sent to the other subscribers, who then give their experience (if any) with the account concerning which inquiry is made. In other words, there is mutual exchange of experiences with the particular account. A variation of this method of operation consists in having the bureau itself "check" the credit of the would-be purchaser. It then keeps the data in its own office and merely advises the subscriber of its conclusions, stating that it would or would not ship the goods. The form employed by the bureau in obtaining information in general among other things calls for (1) the amount owing by the customer to the member, both not yet due and overdue, and (2) the recent payment experience with the customer, whether prompt or slow. These items in fact provide the nucleus for an index of collection conditions. Especially will this be so where data in addition are obtained showing the amount on order by the account, but as yet undelivered. This item gives an indication of merchandising activity in the industry, while the other two items reflect the collection situation. These three items can then be compiled regularly by the credit exchange bureau from the responses to subscribers' inquiries, and a reflection thus obtained of the collection situation in the field which the bureau embraces.

A considerable number of bureaus of the purely credit exchange type as contrasted with the checking type are in existence today. Some are purely local, operating either among several trades in a given city, or in a large center, within one trade only, while other bureaus operate within a given industry. Certain of the latter are affiliated with trade associations in these industries. Bureaus operating on a national scale, however, are extremely rare. The National Association of Credit Men has developed plans for a bureau on a national scale, which it will institute on January 1, 1921. In 1916 the statement was made by a leading authority that only one such bureau existed, namely, the Credit Clearing House.* This bureau in its *Credit Barometer* covers mainly the apparel and textile lines. The *Barometer* in its weekly and monthly forms is stated to embrace respectively over 50,000 and over 200,000 transactions. Monthly comparisons giving percentage of increase or decrease for the country as a whole and for six sections are made with the previous month, and with the same month during previous years, while weekly comparisons, giving percentage of increase or decrease, are made with last week and the same week last year and two years ago. No definite and continuous series, however, is shown, the nearest approach consisting of a graph depicting the situation for each of the three items for the country as a whole by months since January, 1916, but no scale is attached.

In constructing the barometer, the experiences obtained on each subject of inquiry are added. The three items indicated above are taken, namely, unfilled orders (called "purchase activities"), amount owing, both not yet due and overdue (called "indebtedness") and payment experience, whether prompt or slow (called "payment activities"). It may have appeared above that dollar amounts shown in subscriber's returns would be added. The Credit Clearing House, however, employs the number rather than the volume, and constructs its barometer by dividing the total number of accounts successively into the number of purchases reported, the number of accounts owing, and the number reporting payment experience as prompt. The number of reports varies somewhat from month to month.

In response to an inquiry, it was stated in July, 1919, that

> "The number of firms reporting is not always the same, but it is always large enough so that the law of average brings the percentage to a point where we believe it shows the condition, and we have no standard unit at which we stop.

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*Ettinger and Golieb, *Credits and Collections*. Second Edition. New York, 1917, p. 137. A description of its operations is given on pp. 137–141.

> "The variation from month to month is small. Some months, in the lighter inquiry season or the season when purchases are not being made so heavily, there may be 2,000 or 3,000 experiences less than in months where the buying and inquiring is the heaviest, but this amount, where the experiences are upward of one hundred thousand, cannot play any part in the general percentage average.
>
> "The total number has not increased to any extent since January 1916 except in purchases."

This statement was recently confirmed in conversation with the writer. In connection with an index of this description, the same problems of interpretation of course arise as were indicated above.

It will be observed that in the construction of this type of index data are obtained from individual houses in the ordinary course of business activity. By making the individual purchaser instead of the individual seller the unit about which information is obtained, no additional burden is involved in gathering the information. It is the same with a modification of the method which has been suggested, namely, to obtain from collection agencies data showing the number and volume of accounts placed in their hands for collection. Inasmuch as accounts would not be so treated until the seller had given up hope of himself collecting the account, a reflection would be afforded of the relative volume of absolutely bad accounts. The Credit Clearing House, which also operates a collection service, has recently commenced the compilation of data of this kind, as per the following figures:

1920	*Number*	*Average Size*
June	8,813	$163
July	9,238	172
August	9,964	161

VI

In conclusion the leading points mentioned in the foregoing may be brought together:

1. Two principal methods exist by which an index of collection conditions may be constructed:

(a) Through special reports relative to collections obtained from individual houses by a central agency which prepares composite figures.

(b) Through compilation by a credit exchange bureau of information regularly obtained in the course of its ordinary operations, relative to the credit standing of individual buyers.

2. Great difficulty is experienced in defining the statistical unit to be employed in measuring the status of collections, inasmuch as credit conditions, in particular terms of sale, vary greatly from industry to

industry. These differences are reflected in the methods now employed by individual business houses in following the status of their own collections.

3. Where the problem is approached in the first manner, indicated under (a) above, it would appear best to adapt the method employed to the methods now in use by the individual business house in that industry, varying the method from industry to industry in accordance with the credit conditions peculiar to each. In industries where no relatively standard method is employed, adaptation of the methodology to the records of business houses and to the credit conditions in the industry would be necessary. We thus gain in the more perfect reflection by the index of the collection situation in the given industry, but on the other hand lose in that our data, due to differences in methods of constructing the index in different industries, lack comparability as between these industries.

4. Only one instance has been noted of the construction of an index in the second manner, mentioned above under (b). Reports obtained in this manner, of course, are limited to the credit information given on the blank employed, as use must be made of these items. The principal problems which then arise in its construction relate to the choice of a number of accounts versus quantities in dollars, the construction of a strictly continuous series employing the same firms each month, the selection of the industries to be included, and the method of presenting the index, whether, as in the illustration mentioned above, past due accounts each month be shown as a percentage of total accounts that month, etc. The problems in this connection do not differ greatly from those experienced in the construction of the other type of index with the exception that the field of choice is much narrower, due to the small variety of items with which to work.

5. It would appear that advantageous use might be made of the credit interchange bureau in certain industries. In many, however, it would be necessary to obtain special reports from individual houses relative to the status of collections. More important than the question of choice between these two methods of approach is the actual gathering of data showing the collection situation in order that through careful analysis of the same, conclusions may be reached on the various issues indicated above and the way be paved for an accurate and scientific index of collection conditions.

ON THE COSTS OF TUBERCULOSIS

By Louis I. Dublin, *Metropolitan Life Insurance Company*
and
Jessamine Whitney, *National Tuberculosis Association*

This paper is the result of studies made by the Metropolitan Life Insurance Company and the National Tuberculosis Association in order to shed additional light on the question of the economic cost of tuberculosis. Such investigation is a necessary part of the national anti-tuberculosis campaign. Public health work, as now practiced, is often expensive. In the effort to obtain the necessary appropriations with which to carry on their work, health officers are learning to utilize figures showing the economic loss sustained by preventable sickness and premature death in their respective communities. Facts of this kind carry much weight with hard-headed municipal authorities. Altogether, the program of health work is by this means put on a much safer footing. Such figures indicate the relative value of the several types of life conservation work when there is competition between them for public attention. Furthermore, they make it possible to show the character of the returns on the investment when work has been carried on for some time. The health officer who approaches his work from the point of view of the economic factors involved is more likely to keep his feet on the ground and to give a better accounting of his activities.

The first step in our method has consisted in preparing a series of life tables. These show on the one hand, the life expectation including all deaths and on the other, the expectation with tuberculosis excluded. The differences between the life expectation shown in these pairs of tables thus indicate the average number of years of life lost to each individual in a community because of the presence of tuberculosis; and conversely, the average number of years that would be added to the life span if we lived in an ideal community in which deaths from tuberculosis did not occur, and if other causes of death continued at prevailing rates. The method is not a new one. Professor Glover at the International Congress on Tuberculosis held in Washington in 1908 made such a presentation, but based it on the male population of the Registration States for the year 1900. Our purpose was to extend these observations to a later date and to include for comparison a group of insured persons among whom a fairly intensive campaign against tuberculosis had been made. Our material is based accordingly upon the experience of the millions of insured wage-earners in the Industrial Department of the Metropolitan Life Insurance Company for a period of six years, 1911–16, and upon the facts for the total population of the Registration States as constituted in 1910. This area comprised 21 states and a little over half the population of the entire country. In the insurance experience it was possible to make distinction between the color and sex of the policyholders. In the general population this could not be done and it was necessary, therefore, to limit the study to the population as a whole without finer distinction. The two sets of findings serve as supplements to one another and, as we shall see, confirm in the main the accuracy of the methods* employed and of the results obtained.

The following table shows for each fifth year of age, beginning with age 0 for the group of wage-earners and with age 20 for the general population, the average after-lifetime, both when tuberculosis is present and when it has been completely eliminated as a cause of death.

TABLE I

AVERAGE AFTER-LIFETIME OF SPECIFIED POPULATIONS, WITH AND WITHOUT TUBERCULOSIS—ALL FORMS. BY COLOR AND BY SEX FOR INSURED WAGE-EARNERS, 1911-16 AND FOR TOTAL POPULATION OF REGISTRATION STATES, 1910

Age	Metropolitan Life Ins. Co., industrial policyholders, 1911–16								Population, registration states, 1910	
	White				Colored					
	Males		Females		Males		Females			
	Tbc. present	Tbc. absent	Tbc. present	Tbc. absent	Tbc. present	Tbc. absent	Tbc. present	Tbc. absent	Tbc. present	Tbc. absent
0	46.0	49.5	51.8	54.4	37.2	42.2	38.6	43.7	†	†
5	50.3	54.1	55.2	58.0	45.0	50.6	46.1	51.6	†	†
10	46.1	50.0	51.1	53.8	41.1	46.5	42.4	47.7	†	†
15	41.7	45.5	46.7	49.3	37.1	42.2	38.6	43.3	†	†
20	37.4	41.1	42.5	44.8	33.8	38.2	35.7	39.4	44.2	46.6
25	33.5	36.8	38.5	40.4	30.8	34.4	32.9	35.5	40.3	42.3
30	29.8	32.6	34.7	36.1	27.7	30.6	29.8	31.7	36.5	38.1
35	26.4	28.6	31.0	32.0	24.9	27.1	26.7	28.0	32.7	33.9
40	23.2	24.9	27.3	28.0	21.9	23.6	23.6	24.5	28.9	29.9
45	20.1	21.3	23.5	24.0	19.1	20.3	20.6	21.2	25.2	26.0
50	17.2	18.0	19.9	20.3	16.4	17.2	17.7	18.1	21.6	22.1
55	14.4	14.9	16.4	16.7	13.8	14.4	14.9	15.2	18.1	18.5
60	11.7	12.0	13.3	13.5	11.4	11.8	12.3	12.5	14.9	15.2
65	9.3	9.5	10.6	10.7	9.5	9.7	10.1	10.2	11.9	12.1
70	7.3	7.4	8.4	8.5	7.7	7.9	8.0	8.1	9.4	9.5
75	5.7	5.8	6.7	6.7	6.4	6.5	6.3	6.4	7.1	7.2
80	4.6	4.6	5.1	5.1	5.4	5.5	5.3	5.3	5.3	5.4
85	3.6	3.6	4.0	4.0	4.5	4.5	4.5	4.5	4.0	4.0
90	2.9	2.9	3.0	3.0	4.0	4.0	4.1	4.1	2.9	2.9
95	2.4	2.4	2.4	2.4	3.1	3.1	3.2	3.2	1.9	1.9

The loss of expectation of life due to tuberculosis is the difference between the corresponding figures in Table I at each age and is shown in the following table:

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* A statement of the methods employed is presented in the Appendix, pp. 66.

† Data not computed.

TABLE II

LOSS IN YEARS OF AVERAGE AFTER-LIFETIME DUE TO TUBERCULOSIS—ALL FORMS

Age	Metropolitan Life Ins. Co., industrial policyholders, 1911–16				Population, registration states, 1910
	White		Colored		
	Males	Females	Males	Females	
0	3.5	2.6	5.0	5.1	*
5	3.8	2.8	5.6	5.5	*
10	3.9	2.7	5.4	5.3	*
15	3.8	2.6	5.1	4.7	*
20	3.7	2.3	4.4	3.7	2.4
25	3.3	1.9	3.6	2.6	2.0
30	2.8	1.4	2.9	1.9	1.6
35	2.2	1.0	2.2	1.3	1.2
40	1.7	.7	1.7	.9	1.0
45	1.2	.5	1.2	.6	.8
50	.8	.4	.8	.4	.5
55	.5	.3	.6	.3	.4
60	.3	.2	.4	.2	.3
65	.2	.1	.2	.1	.2
70	.1	.1	.2	.1	.1
75	.1	..	.1	.1	.1
80	..	..	.1	..	.1
85	..	..	..	..	..
90	..	..	..	..	..
95	..	..	..	..	..

The importance of the disease is indicated by the extent to which it shortens the average span of human life. Among insured wage-earners tuberculosis is a very powerful anti-longevity force. White males lose 3.5 years in all, or 7.6 per cent of their entire expectancy; white females, 2.6 years or 5 per cent of their expectancy. The heaviest losses occur among the colored people. Colored males and females lose an average of about 5 years of life because of the inroads of this disease, or 12.0 and 13.2 per cent, respectively. On the whole, males lose more heavily than females from tuberculosis. The slightly greater loss among colored females at age 0 is due to the high tuberculosis death rates prevalent among them under age 5; later in life the colored males show much greater losses than do colored females.

There is a gradual decrease with advancing age in the number of years of life lost on account of tuberculosis. Thus at age 20, when productive life is well started for most people, tuberculosis reduces the expectancy 3.7 years among white males, 2.3 years among white females, 4.4 years among colored males, and 3.7 years among colored females. At age 40, the years lost are from one-third to one-half as many as at age 20, and at age 60 and thereafter the losses cease to have an important effect upon longevity although the death rates from tuberculosis continue to be high, even at these advanced ages.

The loss in years of life is obviously greater among insured wage-earners than among the general population because tuberculosis death

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* Data not computed.

rates are uniformly higher among the industrial groups. But even in the general population the loss in years is 2.4 at age 20, 1 at age 40, and 0.3 of a year at age 60.

The extent of the damage from tuberculosis appears to be closely associated with the life expectancy of the population in question whether we consider tuberculosis as a factor in mortality or entirely eliminate it. The loss from tuberculosis is high where longevity is low and is low where longevity is high. Thus at age 0, tuberculosis decreases the span of life 3.5 years for insured white males, but only 2.6 years among the longer lived white females, and about 5 years among the much shorter lived colored policyholders. The coefficient of correlation between longevity and the loss of longevity due to tuberculosis, based upon one hundred observations among insured wage-earners, is 0.791±0.076.

TABLE III

TABLE FOR 100 OBSERVATIONS* AMONG INSURED WAGE-EARNERS, 1911-16, OF THE METROPOLITAN LIFE INSURANCE COMPANY, SHOWING CORRELATION BETWEEN LONGEVITY AND LOSS IN LONGEVITY FROM TUBERCULOSIS

		Longevity		Totals
		Low	High	
Loss in Longevity	High	a 43.5	b 7	a+b 50.5
	Low	c 15.5	d 34	c+d 49.5
	Totals	a+c 59	b+d 41	N 100

This suggests that the conditions of constitution and environment which determine the mortality from tuberculosis also in a measure determine the death rates from other important causes. Another possibility which must be considered is that the amount of mortality from tuberculosis may be determined by the prevalence of certain diseases which like typhoid fever, malaria, hookworm, and syphilis, undermine resistance; and that, conversely, tuberculosis, when prevalent, helps to impair physical vigor and thus increases the death rate from the so-called "degenerative diseases," such as heart disease, Bright's disease, and arteriosclerosis. All three factors are probably at work in different degrees in different communities. Tuberculosis does not stand isolated but is closely bound up with environmental conditions on the one end and constitutional factors on the other, being determined by and determining the rate of loss from other diseases. This question is being attacked by means of a study of the losses of longevity from other important causes and will be reported upon at a later date.

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* The 100 Observations consisted of 25 random ages for the series White Male, White Female, Colored Male, and Colored Female. The dividing lines between high and low for any series were furnished by the average longevity and the average loss in longevity from tuberculosis respectively, for that particular series.

Our next step was to express the losses in expectation described above in terms of estimated money losses. The importance of tuberculosis as a factor in national economy is in this way brought home more sharply. After an examination of the available data on wealth, income, and production in the United States, we concluded that a loss of one year of life was equivalent to a money loss of not less than $100 in national wealth. This conclusion was submitted to a group of economists who have busied themselves with such questions and they confirmed this estimate as in accordance with the best data available. We may say, therefore, that each year of life expectancy lost from tuberculosis by the population of the United States represents a loss of $100 in national wealth. In view of the fact that tuberculosis mortality cuts approximately two and one-half years from the complete life expectation of every individual under present mortality conditions, the loss per person is at least $250. This, in a population of approximately one hundred and six millions, represents a loss of twenty-six and a half billions of dollars. The present generation would add that much more net wealth if tuberculosis were not a factor in mortality. Since the average lifetime is approximately fifty years in the United States, this loss means an annual charge in excess of five hundred million dollars from the curtailed longevity of individuals because of tuberculosis.

No consideration has as yet been given to the very large additional losses which result from the long periods of sickness due to tuberculosis. The losses from disability for work, the cost of medical, nursing, and extra dietary and other care, add very materially to the figures quoted above. It is not possible for us at this time to offer even an estimate of this loss. The amount is enormous. One of us in a study of the records of the Association for Improving the Condition of the Poor (New York City), which has for a number of years conducted intensive relief measures for the care of tuberculous families, found that a tuberculous family was under care, on the average, for a period of two years, four and one-half months, and that during this time the families suffered a wage loss of $836 and the Association contributed $1,181 in relief and care. These data are not sufficient in themselves to determine the community loss in tuberculous families, but they suggest how much the items will be when more extensive and more detailed information becomes available.

Our study has shown the important part that tuberculosis plays as a factor in modern economic life. The amount of damage done is great enough to justify large expenditures for the control of tuberculosis as a cause of sickness and death. The tuberculosis death rate has declined and is still declining. Among industrial policyholders of the Metropolitan Life Insurance Company the death rate has in recent years been reduced very rapidly. In this organization special efforts have been made to instruct the great body of policyholders in methods of preventing and combating the disease, apparently with good results. The death rate from tuberculosis of the lungs in the entire experience has declined 30.3 per cent between 1911 and 1919. During 1920, to date, the experience is reaching low figures previously thought to be unattainable. In fact, the tuberculosis death rate of insured wage-earners is now almost as low as in the general population, although ten years ago there was an excess of 41 per cent in the death rate among these people as compared with that of the general population. In view of the complexity of the problem it is not possible to measure with any exactness the direct relation between the various efforts expended and the results obtained by the anti-tuberculosis campaign. Yet the results are indicative that the work has borne fruit. These achievements clearly call for a continuance of the anti-tuberculosis program along the lines now being followed.

APPENDIX

METHOD OF CONSTRUCTING AND GRADUATING THE INSURANCE* TABLES

METHOD OF CONSTRUCTION

The number of lives exposed to risk, the number of deaths from all causes and from all forms of tuberculosis, were obtained from the public health statistical records of the Industrial Department for the years 1911 to 1916. A complete tabulation of the deaths according to color, sex, and age is shown in a publication by the Metropolitan Life Insurance Company, entitled "Mortality Statistics of Insured Wage-Earners and Their Families." In these tables, age distinctions are shown by single ages under 5 years and by 5-year groupings up to the group "75 years and over." The data were graduated by interpolation formulae and these processes were applied to the exposures and to the deaths from all causes and from tuberculosis—all forms.

The pivotal values were obtained by means of Formula I. The q_x

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* The mathematical work of this paper was carried out by Mr. Frank Langellotti, formerly of the Statistical Bureau of the Metropolitan Life Insurance Company.

values were computed by means of Formula II, formula (a) being used for all causes of death and (b) for tuberculosis. The differences were tabulated as far as and including the fifth difference and the intermediate q_x was derived by the osculatory interpolation Formula III. The q_x values beyond age 70 were obtained by Formula IV. (For tuberculosis beyond age 75, the insurance figures were adjusted in accordance with the general age trend of mortality from tuberculosis—all forms, in the data of the registration area of the United States.) For both, all causes of death and tuberculosis, the values for single ages, 0 to 1, were computed by Formula V. The q_x values for ages 2, 3, and 4 are ungraduated, while those for ages 5 and 6 were computed by Formula VI. Two life tables were constructed, the one based upon the q_x values for all causes of death and the other, upon q'_x in which the q'_xs for tuberculosis—all forms were eliminated.

The tetrachoric coefficient of correlation and its probable error were obtained by VII and VIII respectively.

Formulae

$$u_{x+7} = \cdot 2w_{x+5} - .008\Delta^2 w_x \tag{I}$$

where

$$w_x = u_x + u_{x+1} + \ldots + u_{x+4}$$

$$q_x = \frac{\theta_x}{L_x + \frac{1}{2}\theta_x} = \frac{\theta_x}{l_x} \qquad \text{(a)}$$

$$q'_x = \frac{\theta'_x}{l_x} \qquad \text{(b)} \tag{II}$$

where θ_x represents deaths, L_x the mean population, both for age x to $x+1$; and the prime signifies tuberculosis.

$$\begin{aligned} u_{x+n'} = u_x + n\Delta u_x + \frac{n(n-1)}{2}(\delta^2 u_{x+5} - 1/6\delta^4 u_{x+5}) \\ + \frac{n(n-1)(n-2)}{6}(\delta^3 u_{x+5/2} - 1/6\delta^5 u_{x+5/2}) \end{aligned} \tag{III}$$

where the δ's are central differences, n' is the interpolation interval, and n is n' divided by the tabular interval.

In terms of ordinary differences (III) becomes

$$\begin{aligned} u_{x+n'} = u_x + n\Delta u_x + \frac{n(n-1)}{2} \cdot (\Delta^2 u_x - 1/6\Delta^4 u_{x-5}) \\ + \frac{n(n-1)(n-2)}{6} \cdot (\Delta^3 u_{x-5} - 1/6\Delta^5 u_{x-10}) \end{aligned} \tag{III$'$}$$

$$\Delta q_{70+x} = \Delta q^{G}_{70+x} \cdot \frac{q^{G}_{105} - q_{70}}{q^{G}_{105} - q^{G}_{70}} \tag{IV}$$

where *G* signifies Glover's City Table in case of white and Registration States Table in case of colored

$$q_{70+x} = q_{70+(x-1)} + \Delta q_{70+(x-1)}$$

$$\begin{aligned} q_0 &= \frac{q_2}{q^{G}_2} \cdot q^{G}_0 = kq^{G}_0 \\ q_1 &= kq^{G}_1 \end{aligned} \tag{V}$$

where *G* means the same as in (IV)

Lagrange's formula:

$$\begin{aligned} q_x = q_a &\cdot \frac{(x-b)(x-c)\,.\,.\,(x-n)}{(a-b)(a-c)\,.\,.\,(a-n)} \\ + q_b &\cdot \frac{(x-a)(x-c)\,.\,.\,(x-n)}{(b-a)(b-c)\,.\,.\,(b-n)} \\ + &\ .\ .\ .\ .\ .\ .\ .\ .\ . \end{aligned} \tag{VI}$$

$$\left.\begin{aligned} r &= \sin\left(\frac{\pi}{2} \cdot \frac{1}{(1+K^2)^{\frac{1}{2}}}\right) \\ K^2 &= \frac{4\,abcdN^2}{(ad-bc)^2(a+d)(b+c)} \end{aligned}\right\} \tag{VII}$$

$$pe_r = 3\left(.6745\frac{1-r^2}{\sqrt{n}}\right) \tag{VIII}$$

I, II, III, and VI may be found in *Actuarial Studies No. 4*, published by the Actuarial Society of America; VII, in Davenport's *Statistical Methods;* and VIII, in Elderton's *Frequency Curves and Correlation.*

METHODS OF CONSTRUCTING AND GRADUATING THE REGISTRATION AREA TABLES

The methods of graduating the data for the population of the registration area of the United States were as follows. The mean population (L_x) at quinquennial intervals was computed by Formula I. The number of deaths, both from all causes and from all causes excepting tuberculosis—all forms, were similarly treated. The pivotal central death rates obtained by Formula IX were transformed into q_x values by means of Formula X. For the pivotal values of q_x

beyond age 87, a constant fourth difference was calculated from Formula XI and applied continuously to obtain the lower differences and finally the q_x values themselves. The intermediate q_x values were derived by means of the osculatory Formulae XII and XIII. The former was used for the age range, 22 to 82 years, and the latter for the portions from ages 17 to 22 and from 82 to 97 years. The q_x values at ages 98, 99 and 100 were derived by means of the constant third and fourth single-year differences from Formula XIV. From ages 5 to 17, the computations were obtained from Formula XV by applying the differences upwards.

Formulae

$$m_x = \frac{\theta_x}{L_x} \qquad \text{(IX)}$$

$$q_x = \frac{2m_x}{2+m_x} \qquad \text{(X)}$$

$$\Delta^4 q_{72} = \frac{1}{25.5024}(q_{105} - q_{72} - 6.6\Delta q_{72} - 18.48\Delta^2 q_{72} - 28.336\Delta^3 q_{72})$$

in which q_{105} is assumed to be unity (XI)

$$\begin{aligned}
\nabla u_{x+10} &= \left(\frac{\Delta}{5} + \frac{8}{5^2}\Delta^2 + \frac{11}{5^3}\Delta^3 - \frac{11}{5^4}\Delta^4 + \frac{\Delta^5}{5^4}\right)u_x \\
\nabla^2 u_{x+10} &= \left(\frac{\Delta^2}{5^2} + \frac{6}{5^3}\Delta^3 + \frac{\Delta^4}{5^4} + \frac{3}{5^4}\Delta^5\right)u_x \\
\nabla^3 u_{x+10} &= \left(\frac{\Delta^3}{5^3} + \frac{4}{5^4}\Delta^4 - \frac{3}{5^4}\Delta^5\right)u_x \qquad \text{(XII)} \\
\nabla^4 u_{x+10} &= \left(\frac{1}{5^4}\Delta^4 - \frac{2}{5^4}\Delta^5\right)u_x \\
\nabla^5 u_{x+10} &= \frac{1}{5^3}\Delta^5 u_x
\end{aligned}$$

where ∇ signifies single-year differences

$$\begin{aligned}
\nabla u_{x+5} &= \left(\frac{1}{5}\Delta + \frac{3}{25}\Delta^2 - \frac{2}{125}\Delta^3\right)u_x \\
\nabla^2 u_{x+5} &= \left(\frac{1}{25}\Delta^2 - \frac{2}{125}\Delta^3\right)u_x \qquad \text{(XIII).} \\
\nabla^3 u_{x+5} &= \frac{3}{125}\Delta^3 u_x
\end{aligned}$$

$$\begin{aligned}\nabla^3 q_{95}&=\frac{1}{90}(6q_{102}-q_{105}-5q_{95}-32\nabla q_{95}-81\nabla^2 q_{95})\\ \nabla^4 q_{95}&=\frac{1}{35}(q_{102}-q_{95}-7\nabla q_{95}-21\nabla^2 q_{95}-35\nabla^3 q_{95})\end{aligned}\qquad\text{(XIV)}$$

using this value as a constant

$$\begin{aligned}\nabla^2 q_{18}&=\frac{1}{1365}(143q_{12}-10q_5-133q_{18}-728\nabla q_{18})\\ \nabla^3 q_{18}&=\frac{1}{20}(q_{12}-q_{18}-6\nabla q_{18}-15\nabla^2 q18)\end{aligned}\qquad\text{(XV)}$$

using this value as a constant.

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THE EFFECTS OF VARYING THE RATE OF THE TAX ON SPIRITS

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The history of the spirits tax in the United States shows the tax to have been one of extremely varying rate. Fluctuating from 20 cents to $2 per gallon in the Civil War,[*] the tax was finally reduced to 50 cents in 1868.[†] In 1872 it was raised to 70 cents,[‡] in 1875 to 90,[§] and in 1894 to $1.10.[||] It remained at this figure until the recent war when, in 1917, it became $2.10 for non-beverage spirits and $3.20 for the beverage article,[¶] and in 1919, rose to the unprecedented figure of $6.40 for drinkable spirits and $2.20 for spirits used for other purposes.[**] The rates appear to have been the result of legislative caprice, and surely were not arrived at through any scientific study of the problem. It is interesting, therefore, to see if Congress and the officials did hit upon the most satisfactory rates; and, in particular, whether the rates adopted were designed to yield the largest public revenue.

In analyzing the effects of the rates of the spirits tax, history is helpful; but too much emphasis should not be given to the results of the Civil War rates. The experience of any one period is not sufficient to determine what may be the maximum revenue point in the taxation of a commodity. David A. Wells, who wrote much in his day about the taxation of spirits, was, in the opinion of the writer, guilty of this error. In 1893, in a letter to Secretary Carlisle who had asked him whether it was his opinion that the 90-cent rate should be raised, Wells wrote that there should be no change in the tax, citing in support of his position (among other facts) the results of the Civil War.[††] He asserted that it was shown in the sixties that the spirits tax should not be made too high, pointing out that the revenue increased greatly after the reduction of the rate in 1868 to 50 cents. But reasoning on the basis of the past does not settle the question of what the rate should be for the future, nor can the results of the Civil War tell us whether the later rates were as high as they should have been. What was an inexpedient tax at one period might have been satisfactory at another. Conditions in 1893 were very different from those in the Civil War. The administrative machinery of the internal revenue department was much more efficient, the standard of public service was higher, the public demanded better performance on the part of officials, conditions of production had changed, and it was easier to collect the tax from large-scale producers than from small distillers.* One must look, then, to facts other than the experience of the Civil War in order to decide whether the tax on spirits was as high as it could have been profitably.

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[*] Act of July 1, 1862, 12 U. S. Stat. at Large, p. 447—20 cents; Act of March 7, 1864, 13 U. S. Stat. at Large, p. 14—60 cents; Act of June 30, 1864, 13 U. S. Stat. at Large, p. 243—$1.50 for the period up to February 1, 1865; after that date, $2; Act of December 22, 1864, 13 U. S. Stat. at Large, p. 420, by which the date on which the $2 rate was to go into effect was changed to January 1, 1865.

[†] Act of July 20, 1863, 15 U. S. Stat. at Large, p. 125.

[‡] Act of June 6, 1872, 17 U. S. Stat. at Large, p. 238.

[§] Act of March 3, 1875, 18 U. S. Stat. at Large, p. 339.

[||] Act of August 28, 1894, 28 U. S. Stat. at Large, p. 563.

[¶] Act of October 3, 1917, 40 U. S. Stat. at Large, p. 309.

[**] Act of February 24, 1919, 40 U. S. Stat. at Large, p. 1105.

[††] Finance Report for 1893, pp. 1104–1109. Letter of D. A. Wells to Secretary Carlisle dated July 8, 1893.

One cannot decide on the rate of tax that will yield the maximum revenue in the case of any commodity without examining the effect of its taxation upon its consumption. If by raising prices taxes reduce consumption, it is important to fix the rates low enough not to curtail revenue but not so low as to lose receipts. In the case of commodities possessing an elastic demand, there is a maximum revenue point which ought to be discovered by the government. Unfortunately, the relation of the taxation of spirits and their consumption has been little studied in this country, and on this point it will be very difficult to reach any conclusion. During the Civil War David A. Wells published his results of a study of spirits consumption in the *Report of the Special Revenue Commission,* of which Commission he was chairman.† He later brought this study up to 1879.‡ His general conclusion seems to be that taxation seems to have very little permanent effect upon consumption although there may be some temporary reduction. There is warrant, therefore, for examining the statistics of consumption in the light of the whole experience.

In Table I is given the total and per capita consumption of spirits in the United States for various years. These figures are taken from the *Statistical Abstract of the United States,* but they must be used with great caution. The annual consumption by the population is arrived at by adding to the quantity of home spirits withdrawn for use the amount of foreign imported goods less the exports of the domestic product. The per capita figure is then obtained by dividing this total by the estimated population for that year. However, the apparent consumption indicated by the net quantity imported plus the quantity withdrawn at home may not equal the quantity actually used in the

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* Howe, F. C.: *Taxation and Taxes in the United States under the Internal Revenue System,* p. 230. The author points out that Wells was not warranted in condemning a higher tax in later years because one so high was not successful under earlier conditions.

† Special Report No. 5 of the Revenue Commission, p. 187.

‡ *Cf.* his article in the *Princeton Review,* July, 1884, pp. 87–104, and reprinted in his *Practical Economics,* pp. 180–193. It would be an interesting contribution to economic literature if a special study were made of the relation of the taxation of alcoholic drinks to their consumption.

TABLE I

CONSUMPTION OF DISTILLED SPIRITS* IN THE UNITED STATES, 1863–1918.

Year	Total consumption	Per capita	Year	Total consumption	Per capita
1863	17,409,596	.52	1891	91,157,565	1.43
1864	87,002,067	2.55	1892	97,301,840	1.49
1865	17,484,302	.50	1893	101,287,753	1.52
1866	15,577,386	.44	1894	90,541,209	1.34
1867	15,885,460	.44	1895	78,655,063	1.14
1868	8,453,485	.23	1896	70,725,745	1.01
1869	63,443,582	1.68	1897	73,029,948	1.02
1870	79,895,708	2.07	1898	81,594,293	1.12
1871	64,059,661	1.62	1899	87,433,442	1.18
1872	68,422,280	1.68	1900	97,356,864	1.28
1873	68,037,139	1.63	1901	103,455,338	1.31
1874	64,540,090	1.51	1902	107,726,141	1.34
1875	66,120,558	1.50	1903	117,669,954	1.43
1876	59,983,890	1.33	1904	121,087,387	1.45
1877	59,420,118	1.28	1905	120,869,649	1.42
1878	51,931,941	1.09	1906	127,851,583	1.47
1879	54,278,475	1.11	1907	140,084,436	1.58
1880	63,526,694	1.27	1908	125,379,314	1.39
1881	70,607,081	1.38	1909	121,130,036	1.32
1882	73,556,976	1.40	1910	133,138,684	1.42
1883	78,452,687	1.46	1911	138,585,989	1.46
1884	81,128,581	1.48	1912	139,496,331	1.44
1885	71,416,709	1.27	1913	147,745,628	1.50
1886	73,229,114	1.28	1914	143,447,227	1.43
1887	71,072,794	1.21	1915	127,159,098	1.25
1888	75,845,352	1.26	1916	139,973,684	1.35
1889	80,613,158	1.32	1917	167,740,325	1.60
1890	87,829,623	1.40	1918	119,926,258	1.12

United States. There are three possible reasons for this. First, in those years which preceded or were marked by an increase in the rate, large quantities of spirits were manufactured and withdrawn to escape the payment of the larger tax and sold at the advanced price, with the result that the number of gallons of spirits paying tax were in excess of the amount used in those years. Moreover, when such large quantities of spirits were taken out in periods immediately preceding an alteration in the tax, smaller amounts than usual were withdrawn in years subsequent to the change. The consumption figures based on withdrawals for such years before and after a change in the tax do not show the actual quantity of spirits used. For this reason one must discard entirely or use with great caution the data for years immediately affected by rate changes.

The second explanation of the possible disparity between the annual withdrawals and the actual consumption lies in the peculiar administrative provision of the law which required that within a definite number of years after spirits were admitted to a bonded warehouse they should be withdrawn.† This requirement frequently necessitated the withdrawal of goods when they were not demanded or needed,* with the result that a certain portion of the spirits annually withdrawn might not have been actually consumed in the year in which it was taken out. There is, unfortunately, no way of telling how much deduction should be made from the annual consumption figures to eradicate this error. But inasmuch as this error may be common to figures for all the years, the value of the per capita data for comparative purposes is not destroyed. A third reason for a possible difference between the actual and apparent consumption of spirits is that the official calculations of the quantity used do not take any account of whisky illicitly manufactured and consumed. But it is probable that the latter does not form a large portion of the liquor used. For these reasons one must be on guard in using the available consumption figures, although the errors which they involve do not vitiate them too much to serve our purpose.

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* *Statistical Abstract of the United States for 1918*, p. 825.

† Before 1868 the tax was paid on spirits as it went into consumption without any limitation on the time within which the tax should be paid. By the Act of 1868 the time during which spirits could go without payment of the tax by storage in bonded warehouses was limited to one year (Act of July 20, 1868, 15 U. S. Stat. at Large, p. 136). In 1878 the bonded period was extended to three years (1 U. S

What, then, do these figures show to be the effect of the taxation of spirits upon its consumption? The first significant change in consumption came in 1869 following the reduction in the tax from $2 to 50 cents. In this year, the consumption increased to 1.68 gallons per capita from .23 in the previous year. But this apparent increase cannot be wholly attributed to the change in the rate, for it doubtless was partly due to the more effective system of administration provided by the new law. At any rate the consumption was not appreciably lessened by the increase in the tax to 70 cents in 1872, especially in view of the fact that consumption after a change may be less than normal merely because of the larger withdrawal preceding the change. The increase in the rate to 90 cents in 1875 reduced consumption for a time, but within seven or eight years the per capita quantity of spirits used had again risen almost to its former level, the average amount during the eighties being 1.33 and during the nineties 1.27 as compared with 1.51 in 1874, the year before the change in the rate. The advance in the tax apparently did not effect any great permanent reduction in consumption.

Stat. at Large, p. 249). Finally, in 1894, the period of storage, tax-free, was lengthened to eight years (Act of August 27, 1894, 28 U. S. Stat. at Large, p. 563). Spirits were thus for a long time treated differently from tobacco and beer for which no limited bonded period was fixed. These commodities were allowed to remain in bonded warehouse for an indefinite period, being withdrawn at the will of the owner on payment of the tax.

* At times large quantities of spirits were exported from the United States tax-free and, stored abroad, were later brought back for sale when demand increased, thus delaying the payment of the tax until actual sale of the goods. The tax was paid when the goods returned to the United States. In this way, the manufacturers of spirits were saved the interest on the taxes which would otherwise have been paid before the goods were sold because of the expiration of the bonded period. *Cf* the *Report of the Industrial Commission*, vol. I, pt. I, p. 93; also *House Report, No. 4165, Fiftieth Congress, Second Session*, p. 9 (The Whisky Trust Hearing). Reference is made also to the unpublished thesis of the writer on "Taxation of Distilled Spirits in the United States," now in the Widener Library, Harvard University.

In 1894 the tax was raised to $1.10 and for some time afterwards the consumption fell off, reaching in 1896 the lowest point since the days of the Civil War frauds,* but in the next decade the quantity of spirits consumed per head again mounted to figures as high as those for some years under the 90 cent tax.† In fact, consumption throughout the two decades after 1900 was almost uniformly large, notwithstanding the fact that the tax rate was the highest it had been since the Civil War.‡ It should be remembered also that the figures after 1906 were reduced by the prohibition movement which set in about that time and steadily grew in strength. This is another reason why the per capita figures for the years since 1906 do not accurately show the effect of taxation. Doubtless under the same taxes, without prohibition, per capita consumption would have been larger.

It is also worth considering whether the relatively light taxation of beer that could be used as a substitute for spirits did not result in a smaller consumption of the latter than might have been the case if a higher tax had been paid throughout this period on fermented liquors. At any rate, Table II shows that from 1863 to 1918 the consumption of beer experienced a tremendous increase, rising from less than 2 gallons per capita to more than 20. Undoubtedly the consumption of spirits would have been greater if that of beer had been less, and this fact raises the question as to whether a higher tax on the latter would not have increased the consumption of the former, and at the same time expanded the receipts from both.

The effect of taxation upon the consumption of spirits has been a debatable question in other countries. The matter was considered in the *Report of the Board of Trade of the United Kingdom* in 1897, but no very definite conclusion was reached. The Board found it difficult to believe that taxation had absolutely no permanent effect on consumption and stated that under increased taxation the amount consumed

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* It is probable that the general depression of the nineties in some part accounts for the decrease in consumption.

† This increase perhaps was due to some extent to the increasing prosperity.

‡ The consumption figures since 1907 do not include denatured alcohol consumed in arts and manufactures and are, therefore, smaller than they might have been. Spirits so used were counted in the quantity consumed before 1907. The quantities of denatured alcohol consumed annually since 1907 are as follows:

1907	3,084,951	1913	16,953,553
1908	5,640,331	1914	17,811,078
1909	7,967,736	1915	25,411,719
1910	10,605,871	1916	84,532,253
1911	11,682,888	1917	93,762,423
1912	13,955,904	1918	90,644,723

The tax undoubtedly retarded the use of spirits in industry, but it could be so used only if tax-free, and this fact does not, therefore, affect the revenue problem.

TABLE II

CONSUMPTION OF BEER IN THE UNITED STATES, 1863–1918. (UNIT=1 GALLON)

Year	Total consumption	Per capita	Year	Total consumption	Per capita
1863	62,372,465	1.87	1891	947,230,519	14.84
1864	97,770,584	2.87	1892	989,309,832	15.24
1865	113,623,255	3.27	1893	1,074,441,071	16.19
1866	159,153,746	4.49	1894	1,036,023,535	15.32
1867	193,060,149	5.33	1895	1,043,033,486	15.13
1868	191,289,305	5.17	1896	1,113,465,966	15.85
1869	197,483,238	5.23	1897	1,069,640,208	14.94
1870	204,756,156	5.31	1898	1,164,500,101	15.96
1871	241,138,127	6.10	1899	1,136,380,908	15.30
1872	270,298,916	6.66	1900	1,222,387,104	16.09
1873	300,697,262	7.21	1901	1,259,060,444	15.98
1874	299,521,065	7.00	1902	1,382,369,176	17.18
1875	294,953,157	6.71	1903	1,450,308,350	17.67
1876	308,336,387	6.83	1904	1,499,378,215	17.91
1877	304,926,667	6.58	1905	1,538,526,610	18.02
1878	317,969,352	6.68	1906	1,700,421,221	19.54
1879	344,605,485	7.05	1907	1,822,313,525	20.56
1880	414,220,165	8.26	1908	1,828,732,448	20.26
1881	444,112,169	8.65	1909	1,752,634,426	19.07
1882	526,379,980	10.03	1910	1,851,666,658	20.09
1883	551,497,340	10.27	1911	1,966,911,754	20.66
1884	590,016,517	10.74	1912	1,932,531,184	19.96
1885	596,102,038	10.62	1913	2,030,347,372	20.62
1886	643,179,459	11.21	1914	2,056,407,108	20.54
1887	717,972,313	12.24	1915	1,855,524,284	18.24
1888	766,491,812	12.78	1916	1,818,275,042	17.59
1889	780,122,461	12.73	1917	1,885,071,304	17.95
1890	855,929,559	13.67	1918	1,556,378,953	14.59

would be less for a time in any case.* Mr. Bence-Jones, who did the statistical work underlying this report, read a paper before the Royal Statistical Society in 1900 in which he stated that apparently it was the experience of certain countries that in times of prosperity more alcoholic drinks were consumed than in periods of depression.† He did not, however, touch the question of the effect of taxation on consumption. Professor Edgeworth in discussing this paper raised the question whether the alleged connection between large consumption and prosperity did not point to the fact that the demand for alcoholic beverages was elastic, and whether, if that were true, taxation would not affect consumption.‡ Shadwell in a careful study of consumption of spiritous liquors in the United Kingdom reaches the conclusion that by taxation it is possible to exercise considerable control over consumption as long as the rate is not made high enough to force illicit traffic.§

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* *Cf. Statement of the Board of Trade* showing the production and consumption of alcoholic beverages in the various countries of Europe and the United States. Parliamentary Papers, 1897, vol. 79, p. 5. This report stated that consumption seemed to vary with the condition of prosperity in a nation, increasing in "good" times, and decreasing in "bad."

† *Statistical Journal of Royal Statistical Society*, vol. 63 (June, 1900), pp. 272–288. *Cf.* also the *Report of the Board of Trade* cited above.

‡ *Statistical Journal*, vol. 63, p. 290.

§ Shadwell, *Drink, Temperance, and Legislation*, p. 152. The effect of taxation on consumption of alcoholic liquor in the United Kingdom had been studied in 1875 by the Rev. Dawson Burns who read a paper upon that subject before the Royal Statistical Society in that year. His conclusion was that

The question was studied in France in the eighteen-nineties by a Committee of the Chamber of Deputies charged with investigating a proposal to create a state monopoly of rectifying alcohol. The Committee examined various schemes for mitigating the alleged deleterious influence of the consumption of alcohol upon the welfare of the people. One of the proposals for meeting the condition was that the consumption of spirits should be curtailed by higher taxation. The Committee after examining the statistics of consumption declared that in the nineteenth century taxation had had no effect on the quantity of alcoholic drink used.[*] In 1830, when the tax was 55 francs per hectoliter, the consumption was 1.12 liters per capita, but in 1831 after the tax was decreased to 37.4 francs, the per capita consumption itself declined to 1.09 liters. Again, in 1855, the consumption per head stood at 2 liters, and although by the law of July 14, 1855, the tax was raised to 60 francs, the quantity used increased to 2.13 liters. The rate was moved up to 90 francs in 1860, but in that year the amount consumed was 2.27, although it was only 2.23 the year before. Although the tax rose again by the law of September 1, 1871, the per capita quantity used in 1872 was 2.09 liters as against 2.81 the year before. The law of December 30, 1873, increased the spirits tax to 156.25 francs and added some special taxes on liqueurs, absinthes, and the like, but in 1875 the per capita consumption had increased to 2.82 liters. It may be objected that the data for sample years which happen to come before and after a change in the rate give no indication of the permanent effect of alterations in the tax. But the statistics of consumption for every year from 1850 to 1895 were given by the Commission,[†] and from these data that body concludes that throughout that period the national taxes did not affect consumption and that the quantity of drink used did not vary with its price,[‡] which would tend to show that the product in that country at least possessed an inelastic demand. This unqualified conclusion is perhaps unwarranted, for doubtless the changes in the tax had some effect on consumption, though it may not have been great.[§]

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taxation of strong drink decreased its consumption, based upon the experience in the United Kingdom. His paper, however, was very severely criticized by others present who had given attention to the subject and believed that the facts did not warrant any such conclusion. *Cf. Journal of the Royal Statistical Society*, March, 1875, vol. 38. pp. 1–32.

[*] *Rapport Seance du 19 Janvier, 1897.* Chambre des Deputes. Appendix No. 2212, Documents Parlementaires, 1897, vol. I, p. 145.

[†] *Report of the Commission*, Documents Parlementaires, 1897, Part I, p. 145.

[‡] *Ibid.*, p. 145. "Nous pouvons donc hardiment déclarer que ni l'augmentation des droits sur l'alcohol ni un relevement du prix de cette denrée ne suffiraient pour en diminuer la consommation."

[§] See above where the position of the Board of Trade on this point was referred to. In the report of the Board (1897) it was stated that it was difficult "altogether to subscribe to the opinion of the French Committee that no increase in the amount of such taxation will have the effect of permanently diminishing the consumption."

There were cited other examples also of the fact that increased taxes did not result in decreased consumption. In 1889, the city of Marseilles increased its octroi duties considerably on alcoholic liquors, but without any effect on their consumption. In fact an increase in revenue followed the change. At one time also in Belgium the spirits tax was raised tenfold, and yet an increase in consumption followed.*

However the matter may be with foreign countries, in America at least the history of spirits taxation shows that, although there was always a temporary reduction in consumption after an increase in the tax, no marked permanent decline in the use of spirits followed advances in the rate. The experience would seem to show that in the long run American spirits possess to some extent an inelastic demand, although there are temporary variations in demand. There was undoubtedly a point above which the government could not go in fixing the rate of the tax, but evidently that point had not been reached. On the basis of the data it would be hard to tell where this point was. Yet the observation is significant from the point of view of revenue because apparently considerably higher taxes might have been laid on spirits for a number of years during the existence of the tax without reducing the consumption so much as not to bring an increased revenue.† It may be said, however, that no such conclusion is warranted from a study of statistics of consumption which do not include the amount of illicit spirits consumed.‡

The objection may be raised that higher taxes would result in frauds and that even if consumption were not reduced, much of the spirits consumed under the higher rates would have been produced in illicit stills and used or sold without payment of the tax, with the result that the treasury might have got no more or even less revenue under the higher rates although as much liquor was consumed as before the increase in the tax. This leads to an examination of the effect of increased taxes on frauds and illicit distilling. The available statistics concerning illicit distilling consist of the number of officers and subordinate employees of the Internal Revenue Service killed and wounded, and the number of seizures of distilleries engaged in violation of the law. These figures do not measure the quantity of spirits unlawfully manufactured, but they are the only data that indicate the extent of the illicit operations. The statistics begin with the year 1877 at which time the Bureau of Internal Revenue began its intensive campaign against illicit distilling.§

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* Report to Chamber of Deputies, p. 161.

† What this rate might have been will be indicated later in this article.

‡ *Cf. supra*, p. 454.

§ For a very readable and complete story of the activities of the commissioner and his subordinates in the suppression of these frauds, *cf. House Executive Document No. 62, Forty-sixth Congress, Second Session.*

TABLE III
REGISTERED STILLS SEIZED, 1877–1918*

1877	598	1898	2,391
1878	1,024	1899	2,190
1879	1,319	1900	1,955
1880	969	1901	1,499
1881	756	1902	1,282
1882	464	1903	1,323
1883	397	1904	964
1884	377	1905	1,053
1885	245	1906	1,376
1886	564	1907	1,139
1887	456	1908	1,130
1888	518	1909	1,743
1889	466	1910	1,911
1890	583	1911	2,471
1891	795	1912	2,466
1892	852	1913	2,375
1893	806	1914	2,677
1894	1,016	1915	3,832
1895	1,874	1916	3,286
1896	1,905	1917	2,232
1897	2,273	1918	†

There were three periods of special activity in illicit distilling followed by declines in illegal operations. Federal prohibition has brought the last period to an end without leaving much evidence on which a prophesy for the future could be made, although in the year 1917 there was a distinct falling off in the figures. The first period of prevalence of illicit operations followed hard upon the increase in the tax-rate in 1875. In Table III it is seen that the number of illicit distilleries seized rose from 598 in 1877 to 1,319 in 1879. Likewise, the greatest number of casualties came, as Table IV shows, in the early period from 1877 to 1881 when the Bureau first sent armed forces against the insurrectionary distillers. This increase in illicit operations can be traced to the change in the rate of the tax. No other explanation can be offered. The higher rate increased the price of spirits, with the result that the attention of distillers was directed to the profits of successful evasion of the tax which were sufficiently attractive to cause illicit distillers to be very numerous and very persistent.‡ Unfortunately there are no statistics to support it, but what evidence there is seems to show that after 1868 illicit distilling was no problem for the government until the tax was raised in 1872 and 1875.§ If, however, the increase in the taxrate caused such an increase in illicit distilling in the seventies, why should the business decline when the rate was still in force? For, by 1885, the number of illicit distilleries seized had fallen to 245, although there was a

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* Figures taken from the *Annual Reports of the Commission of Internal Revenue.*

† Not given in the *Report* for 1918.

‡ *Finance Report for 1893*, p. 1108; *cf.* also Art. in *Sewanee Review* for November, 1893, by Elwood Wilson.

§ This is the position of Elwood Wilson in the *Sewanee Review*, p. 123; *cf.* also D. A. Wells, *Practical Economics*, p. 220.

TABLE IV

CASUALTIES IN THE SUPPRESSION OF ILLICIT DISTILLING, 1877-1917*

Year	Officers or employees killed	Officers or employees wounded	Total casualties
1877	12	8	20
1878	8	17	25
1879	7	19	26
1880	3	7	10
1881	1	9	10
1882	4	1	5
1883	1	0	1
1884	0	1	1
1885	1	0	1
1886	0	1	1
1887	0	1	1
1888	1	1	2
1889	2	2	4
1890	1	1	2
1891	1	3	4
1892	0	1	1
1893	3	0	3
1894	0	0	0
1895	1	2	3
1896	0	3	3
1897	1	3	4
1898	2	5	7
1899	1	3	4
1900	0	0	0
1901	2	4	6
1902	1	2	3
1903	0	0	0
1904	0	1	1
1905	1	0	1
1906	0	0	0
1907	0	0	0
1908	0	0	0
1909	1	0	1
1910	1	3	4
1911	1	2	2
1912	0	1	1
1913	0	2	2
1914	0	1	1
1915	3	0	3
1916	0	3	3
1917	0	3	3
Total	60	110	170

slight increase after that, and by 1894 there were no casualties whatever reported for the year. This decline in illicit distilling may be attributed to two causes: the vigorous opposition of the government to this practice and the greater general efficiency of the internal revenue machinery attained through experience.

In 1895 after the $1.10 tax had gone into effect there was the second increase in illicit distilling, and the seizures in that year amounted to more than a thousand and continued to increase until 1900, after which they began to decrease, falling in 1905 to 954, the lowest point reached since the early nineties. From 1902 to 1910 the total casualties also were very much reduced, three years of this period being characterized by an entire absence of any. Evidently the increase in the rate was the cause of the change in the amount of illicit distilling and for the same reason as under the last change of rate.* Thus, the statistics indicate† that, in the case of the $1.10 rate just as in that of the 90-cent tax, the spurt in illicit distilling was followed by a decrease in that activity when the distillers had been fully impressed with the serious purpose of the government to enforce the law and collect the tax.

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* Figures taken from the *Annual Reports of the Commissioner of Internal Revenue.*

Then there followed an unusual thing in the experience with the spirits tax. Without any change whatever in the rate of the tax, another increase in illicit distilling was observed. In 1906 the seizures began to grow until in 1916 they had reached the unprecedented number of 3,832, and during this period the casualties were more numerous. This third period of illicit activity was due to the spread of prohibition‡ which began in the Southern Commonwealths in 1907. Prohibition created the same condition as an increase in the tax in that it made the profits of fraud so attractive as to tempt large numbers into illicit distilling.§ Under state-wide prohibition the supply of whisky was greatly reduced, so that large prices could be secured for that which was produced. Furthermore, the state-wide prohibition was adopted in those states where illicit distilling had formerly been carried on,‖ which led to revival there. In recent years, the commissioners in their reports have referred to the difficulty of enforcing the law and collecting the tax in those areas where prohibition existed.¶ But prohibition and its effect upon the revenue are foreign to the subject of the present writing. They are mentioned here only in so far as they might have some bearing upon the fixing of the rate.

The conclusion seems to be clear, therefore, that although there was an increase in the amount of illicit distilling following each change in the rate, after a few years the activities of the illegal producers, by the force of the internal revenue service, were very much reduced. The increases in illicit distilling seem to have been due more to disturbance of the tax than to the particular rate which prevailed. When the rate was changed, the added profits of dishonest manufacture were sufficient inducement to bring into the field a large number of distillers, but when the power of the government was brought down on them the operations were curtailed and the number of casualties and seizures became more normal. The prevalence of the illicit operations depended also upon the methods and the efficiency of the administration of the law. More casualties and greater difficulty were met with under the 90-cent tax than under the $1.10 rate. There is no reason to believe that the $1.10 rate would not have been successful. So far as illicit distilling was concerned the statistics show that higher taxes do not in themselves permanently cause more violations of the law. Within certain limits it would seem that high taxes would result in no more difficulty than low, provided that the people became accustomed to them and that violations of the law were vigorously suppressed. It seems that with illicit traffic in spirits, it was more a question of law and efficiency of administration which developed slowly than with the particular rate of the tax. Moreover, it should be remembered in this connection that illicit production was largely confined to the remote mountain regions of the South, that the scale of operation was always limited, and that the total output of illegal stills, being inferior in quality and forming a comparatively small part of the country's product, could not offer very effective competition with tax-paid spirits.*

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* D. A. Wells felt that the frauds under the 90-cent rate were due to the rate, and advised at least against any raise in the tax. *Cf.* his letter to Secretary Carlisle in 1893, *Finance Report for 1893*, p. 1108. Elwood Wilson believed that the advance in the rate to 90 cents increased fraud and recommended a 50-cent tax instead of an advance beyond 90 cents. *Cf.* his article in *Sewanee Review* for November, 1893, p. 120. He attributes the sudden rise in illicit distilling after 1875 to the 90-cent rate. The Acting Commissioner of Internal Revenue, Mr. G. W. Wilson, also seemed, in 1897, to attribute the increase in illicit distilling after 1894 to the increase in the tax and he recommended that the rate be decreased from $1.10 to 90 cents, or even to 70 cents. *Cf.* his letter to the Secretary of the Treasury, April 3, 1897, *Senate Report, No. 411, Fifty-fifth Congress, Second Session*, pp. 555-556.

† These reductions in illicit distilling are also referred to from time to time in the Reports of the Commissioner of Internal Revenue.

‡ *Report of the Commissioner of Internal Revenue for 1910*, p. 77.

§ *Ibid.*, 1912, p. 25; *cf.* also Horace Kephart, *Our Southern Highlanders*, p. 189, where he refers to the profits made by boot-leggers in these districts.

‖ For statistics showing concentration of illicit distilling, see the various reports of the commissioner.

¶ *Cf.*, for instance, *Reports* for the years 1913, 1914, and 1915.

That the revenue was not permanently reduced by increases in tax rates is shown by Table V, which gives the receipts from the spirits tax. Only the data since 1868 are included because the period of the Civil War was too greatly characterized by changing policy and fraud. The figures for the years from 1872 to 1875 are affected by changes too close together to be instructive. But after 1875, when the rate was advanced to 90 cents, although the quantity of spirits withdrawn was temporarily reduced, the annual revenue obtained from the larger tax was increased. By 1880, however, the quantity of spirits withdrawn was as large as before the change in the tax, with a consequent rise in the revenue.† Again in 1893, after the tax was changed to $1.10, the number of gallons paying tax fell off for a few years, but by the close of the century the quantity paying tax had returned to normal, and the revenue before that had risen to its former level. Here again the increased tax, in a few years, brought in larger annual receipts than in the years before the change.

All this experience brings us to conclude that taxes even higher than the $1.10 rate might have been successfully collected from spirits. No great permanent decrease in consumption or increase in illicit distilling would have been expected from the higher rate. Undoubtedly, illicit distillers would have been temporarily active under an increased rate and the consumers would have for a time at least reduced their use of spirits, but the past leads us to think that these results would have been only ephemeral and that in a few years the receipts into the treasury would have indicated the restoration of normal conditions in consumption and illicit operations. Serious frauds and illicit practices were slowly suppressed as the years passed, and with vigorous law enforcement and the changed conditions America, like England, was capable in late years of collecting heavier taxes on spirits. It is of course difficult to say exactly how high the tax might have been made. There is undoubtedly a maximum revenue rate above which advances in the tax would not bring proportionate increases in revenue. Temporary and permanent prohibition have prevented us from seeing the results which would have followed from the $2.20 and the $6.40 taxes imposed in 1917 and 1919,† respectively. In view of the facts, the writer believes it reasonable to think that during the last twenty-five years at any rate, a tax of at least $2 might have been wisely imposed

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* F. C. Howe, *Taxation and Taxes in the United States*, p. 230, where he comments upon the unimportance of the illicit product in the total output of the country.

† *Cf.* the *Reports of the Commissioner of Internal Revenue* for various years for the number of gallons withdrawn.

TABLE V

FEDERAL RECEIPTS FROM SPIRITS IN THE UNITED STATES, 1869-1918*
(IN MILLIONS OF DOLLARS)

Year	Receipts	Year	Receipts
1869	33.7	1894	79.9
1870	39.2	1895	74.8
1871	31.1	1896	75.3
1872	33.1	1897	77.0
1873	43.1	1898	87.7
1874	43.8	1899	93.6
1875	46.9	1900	104.4
1876	51.4	1901	110.9
1877	52.7	1902	115.3
1878	45.6	1903	125.9
1879	47.7	1904	129.6
1880	55.9	1905	129.5
1881	62.2	9106	137.0
1882	64.8	1907	149.7
1883	69.0	1908	133.6
1884	71.7	1909	128.3
1885	62.2	1910	141.5
1886	63.8	1911	148.1
1887	60.6	1912	149.4
1888	64.4	1913	157.5
1889	69.4	1914	153.0
1890	76.5	1915	136.6
1891	79.6	1916	149.8
1892	85.5	1918	181.1
1893	89.2	1917	303.

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* From the *Reports of the Commissioner of Internal Revenue.*

† Acts of October 3, 1917, and February 24, 1919, cited above.

on strong drink.* Whatever the rate should have been, one thing seems clear and that is that for some time before the recent war emergency the federal government did not fully utilize spirits as a source of revenue.†

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* In this connection *cf.* article by Professor Charles J. Bullock in the *Quarterly Journal of Economics* for May, 1917, p. 368, in which he expressed the belief concerning war finance that the tax "on spirits could probably be raised to $1.50 per proof gallon without making it difficult to enforce, and if the Bureau of Internal Revenue so advises, should be increased to $2.00 per gallon."

† It should be mentioned in this connection that in the eighteen-eighties an attempt was made entirely to abolish the revenue from spirits and all internal revenue. *Cf. Debates* in the Congressional Record for 1888, and the platform of the Republican party in that year. *Cf.* also an article by Judge Kelley in the *International Review* for October, 1882, p. 305.

SECOND REPORT OF THE ADVISORY COMMITTEE ON THE CENSUS

A Report of Progress by the Joint Committee of the American Statistical Association and the American Economic Association to Advise the Director of the Census

To the American Economic Association and the American Statistical Association:

The second report of progress of your Joint Advisory Committee to the Director of the Census is respectfully submitted herewith.

ORIGIN OF THE COMMITTEE

At the request of the Secretary of Commerce each of these Associations at the annual meeting held at Richmond in December, 1918, designated three members to represent it upon a joint committee to advise with the Director of the Census concerning the taking, tabulating, and publishing of the Fourteenth Census of the United States. This Joint Committee of six organized for work in February, 1919, and each member was subsequently appointed a special agent of the Census Bureau at the compensation of $1.00 a year. To the annual meeting of each of the two Associations held at Chicago in December, 1919, the first report of progress was submitted. It was later printed in pamphlet form and also in the Quarterly Journal of the American Statistical Association, (Vol. XVII, pages 76–106) and the *American Economic Review*, (Vol. X, supplement pages 267–278).

ACTIVITIES DURING THE YEAR

The present report covers the activities of the Committee from the date of the last report to December 1, 1920. During that period five meetings of the Joint Committee have been held at Washington:

January 23–24, 1920,
April 23–24, 1920,
May 28–29, 1920,
October 8– 9, 1920,
November 19–20, 1920.

The departure last autumn of Professor E. R. A. Seligman, a representative of the American Economic Association, to California to exchange with Professor Carl C. Plehn of the University of California, left a temporary vacancy, and the remaining members of the Committee informally invited Professor Plehn to sit with them on the Committee. This invitation Professor Plehn accepted, and he attended the meetings held on April 23 and 24 and on May 28 and 29. Professor Seligman resumed his place on the Committee at the October meeting.

Twenty-five recommendations in all were adopted at the five meetings of the Committee held during the past year (see Appendix I). Eleven of these related to the presentation of the statistics of population, four to that of the statistics of agriculture, two to that of statistics of manufactures, and eight to general matters of census policy.

The recommendations made by the Committee during 1919 numbered thirty-nine and thus were more numerous than those made during 1920.

This reduction in the number of recommendations does not mean that during its second year the activities of the Committee lessened. On the contrary the Committee believes that its work has increased in value as its members have become more familiar with Census work and have come into closer contact with the Census staff. But it has found its main opportunities for service in the application of the principles set forth in its recommendations to the many current problems of census procedure.

The recommendations made in 1919 dealt with a great variety of subjects pertaining to preliminary organization. During 1920 the sessions of the Committee have been held with the enumeration of the Fourteenth Census either well under way or an accomplished fact. Hence definite problems of statistical policy, form of presentation of tables, and extent and character of text, all matters of extreme importance to the Bureau and many of them subject to long-standing differences of opinion within the office, were referred to the Committee. Full consideration was given each problem presented, and recommendations embodying the Committee's recommendations were made. In nearly every instance these recommendations were accepted by the Bureau. Thus within the past year the census officials have made larger use of the Committee as a court of appeal on disputed points.

POLICIES ADVOCATED

From the beginning of its work the Joint Advisory Committee has had two guiding policies: (1) To aid the Bureau of the Census to expedite the publication of the basic tables relating to population, agriculture, and manufactures, and (2) To aid the Bureau to secure an adequate scientific analysis of the data.

In pursuance of the first aim the Committee has recommended such simplification of the main census reports as will reduce the time required to prepare them for the printer without reducing the scope or accuracy of the fundamental tables. For example, it has accompanied its recommendation that appropriate cartograms be used in bulletins with the proviso that their preparation does not postpone publication more than ten days. Again, believing that the number of percentages and averages included in the final volumes of the Thirteenth Census was so great as to cause delay in the completion of the manuscripts, the Committee has recommended that figures of this description be greatly reduced in the volumes of the Fourteenth Census. Finally, the Committee has twice this year called attention to one of last year's resolutions. ". . . that no text be printed in the bulletins and final reports that is not needed to clarify tables, or to prevent misconstruction of figures, and that all interpretation be reserved for special studies."

This policy has met with the cordial approval of the Director. As a result of its adoption we believe that the members of the two Associations which the Committee represents and the public at large will receive the chief results of the Fourteenth Census months earlier than would have been possible had these volumes been modelled more closely on those of the Thirteenth Census.

This greater promptness of publication the Committee believes to be a decided gain. But great as this gain is, it would be purchased at too high a price if the Bureau of the Census should provide no more adequate analysis of its results than will appear in the main volumes. The Committee lays even more stress upon improving the scientific analysis of the data collected than upon prompt publication.

If these two aims of Census policy—prompt publication and thorough analysis—seem in conflict with each other it is because of defective organization of the census work in the past. Thoughtful analysis is exceedingly difficult to secure while the office feels the pressure for publication of the main reports. Moreover, for thorough analysis of one branch of census statistics careful comparison with other branches is usually necessary. Of course such comparative work is not feasible when each volume is being prepared separately for the printer and every one is working against time. In fact the doubtful value of much of the text in previous censuses is evidence that we cannot expect good analysis to be included in volumes which the law requires to be issued within the census period. It is better to separate the task of printing the tables from that of analyzing the figures; to issue the tables promptly and when they have been printed to submit the more significant to scientific analysis. That is the policy for which the Committee stands.

For this thorough supplemental analysis the Committee has submitted to the Director of the Census a partial list of topics requiring particular attention; and has recommended that for the preparation of these analyses he secure the services of investigators of recognized standing. The Committee is glad to report that the Director has recognized the desirability of this policy and accepted it in principle. But he has not concealed from the Committee his apprehension lest, after the main volumes have been published, it may prove difficult to secure funds for this scientific work.

Under these circumstances the Committee suggests to the two Associations that they express to the Director of the Census their interest in securing a scientific analysis of census results, their support of his policy of employing scientific men for this work, and their willingness to aid him in carrying out this policy.

This matter is of pressing importance in deciding the character and value of the Fourteenth Census. In addition, it has an importance that is not transient. If a supplemental scientific analysis of the results is made the Committee believes that its value will be so clear and its interest so great that scientific study of the results will become a permanent feature of American censuses. Then the two policies for which the Joint Committee has worked—prompt publication and thorough analysis—will appear in their true light; not as rivals but as supplements.

IMPROVING THE FORM OF THE VOLUMES

In considering the subject of the printed presentation of census results the Committee was convinced that an opportunity existed to effect an important reform. It has kept constantly in mind the inconvenience which workers in statistics encounter whenever they consult census publications. The assumption heretofore has been that the quarto page is necessary for the purpose of effectively presenting census tables. This, however, has been disputed by some experts in census table construction and successful experiments already have been made with octavo volumes. The Committee earnestly favors the latter form but after mature consideration it was not convinced that the experiment had proceeded far enough to insure certainty of success in the varied requirements of all the final reports of a decennial census. This being the case, it perceived the gravity of embarking upon a radical change, not fully matured, which, if not successful, would mean confusion, delay, and great expense. Accordingly it adopted the policy of approving the retention of the quarto form for the volumes of the present census and urging a systematic test of the octavo form in all intercensal reports.

The Committee believed, however, that one serious defect in the quarto form could be remedied. To print census volumes upon paper of the weight and thickness of Government contract wood pulp stock seemed unnecessary, and the Committee recommended the use of paper not exceeding 30 pounds per ream standard size. (See Recommendations 31d and 64.) This simple reform would bring relief to all users of census reports, since a quarto volume of 1,000 pages would not much exceed one inch in thickness and would weigh not over four pounds.

REQUIREMENT FOR ADDITIONAL CENSUS FUNDS

It is appropriate to say that, though the officials of the census necessarily labored under great difficulties in making their estimates as to the cost of the Fourteenth Census, they have been able to keep expenditures within the limits of their estimates. Congress, however, in making appropriations for the work thus far has not granted the full amount requested. The total amount asked for (December, 1919) by the Director was $23,765,000; three appropriations have been made, totaling $22,500,000. If Congress will appropriate the remaining $1,215,000, the Bureau continues confident that this amount will suffice to complete the tabulation and publication of the results of the Fourteenth census. On the other hand, if no additional appropriation is made, at the present rate of expenditure, one-third of the decennial census period, namely, a fiscal year, is unprovided for. The possible lack of adequate funds is a factor that must be considered in the plans now pending for the completion and publication of the Fourteenth Census within the legal period.

PROGRESS OF THE FOURTEENTH CENSUS

In conclusion the Committee desires to set forth in considerable detail for the information of the two Associations which it represents, and also for reference in future census work the time schedules and accomplishments of the principal divisions of the Bureau in taking the Fourteenth Census.

For administrative purposes the work of the census falls into five stages. (1) Preliminary work, consisting of the preparation of the schedules and instructions, and appointment and training of the field force. (2) The field work. (3) The receipt of the returns and their preparation for tabulation. (4) The tabulation. (5) The preparation of the final tables and reports.

The work of the first three stages is now virtually finished, at least for population and agriculture; and the fourth finished so far as concerns the distribution of the population of the United States according to states, counties, and minor civil divisions. The field work on the census of manufactures continues through a longer period, and thus the stages of work in this division do not synchronize with those in the Divisions of Population and Agriculture.

A limited time—3 years—being allowed by the law for the completion and publication of the census, it is necessary to decide in advance upon the dates on which certain stages of the work shall be finished. For example, the supervisors should all be appointed months in advance of the date on which the enumeration is to start. The schedules and instructions should all be printed and ready to deliver to the supervisors at the time of their appointment. A time schedule should be drawn up for the beginning of the enumeration; its completion; receiving the schedules at the office; beginning and finishing of editing; beginning and finishing of card punching, sorting, and tabulating; preparing manuscript; and printing.

In compliance with the request of the Committee, the Director furnished statements fixing, so far as possible, the dates on which these various processes should be finished. The Committee is glad to be able to report that the work in the two large divisions of population and agriculture, though somewhat delayed in the early stages, has now been brought up approximately to schedule.

Population

The Population Division is responsible for the instruction of the supervisors and enumerators, also for the shipment of all blanks required for their work; the receipt of the completed returns and their distribution to other divisions of the Bureau.

During July, August, and September, 1919, the Population Division was to prepare and have printed the schedules and instructions to supervisors and enumerators for enumeration of the population, prepare and have printed the special schedules and instructions for the outlying territories of Alaska, Hawaii, Guam, Samoa, Porto Rico, and the Panama Canal Zone, and the military and naval forces stationed abroad, and was to begin the shipment to the supervisors of the supplies required for their office and field work. The division accomplished all of this preliminary work that it was contemplated would be done during the three months, so far as the appointment of the supervisors permitted. By the end of September 357 supervisors out of a total of 372 had been appointed.

The work of the Geographer's Division is closely associated with this initial stage of the work of the Population Division. The Geographer is primarily responsible for the establishment of the boundaries of enumeration districts. A statement of the boundaries in his district is sent to each supervisor for criticism and correction. It was expected that all enumeration districts would be established before September 1, but it was found impossible to accomplish this, and by the end of September the boundaries of enumeration districts for only 351 of the supervisors' districts, or not quite 95 per cent, had been established.

During October, November, and December, 1919, the rest of the supervisors were to be appointed, the boundaries of enumeration districts completed and the enumerators selected and instructed so that they would be in a position to begin work promptly on January 2, 1920, the division to have charge of the correspondence with the supervisors and enumerators was to be organized and a large amount of other miscellaneous work incident to the organization of the field force was to be done.

During these months the schedule also called for the accomplishment of the following work: determining the form of the punch card to be used for the census of population, making final arrangements in regard to the installation of 843 punches, 23 sorting machines, and 30 tabulating machines.

All of the work outlined for the office force was accomplished. By January 1 all the supervisors had been appointed; but owing to the abnormal industrial and social conditions following the war the supervisors found great difficulty in securing qualified persons to act as enumerators, and in a large number of districts the work of enumeration was not started on January 2.

The work called for by the schedule in the first half of 1920 was as follows: To complete the enumeration of the population; to organize the large force of clerks required to make the preliminary hand count of population, and to edit the schedules; to organize the force of operatives for punching the cards; to approve and turn over to the Disbursing Clerk the enumerators' vouchers; to begin the publication of preliminary totals for the population in cities and minor civil divisions; to establish the form of the state bulletin presenting the statistics of population by counties, cities, and minor civil divisions.

The delay in the appointment of the enumerators, principally due to a country-wide scarcity of labor, affected not only the field work but also that of the Bureau at Washington. The severe weather conditions which prevailed throughout the United States during January, February, and even March, also greatly retarded the work of the enumerators. The law contemplates that the enumeration shall be completed in one month. In the majority of the enumerators' districts it was necessary to extend this period, and in a few the work was not completed before July 1; in fact there were three or four districts in which the work was not finished until even later in the year. The first schedules from the enumerators were received on January 15 and the examination and preliminary count were started promptly on January 17. Announcements of population were made for the District of Columbia and Cincinnati, Ohio, on February 21. Editing of the schedules started about February 1, and the punching of the cards on March 1. During the latter part of this period, preliminary announcements for cities, counties, and states, were made daily. Although hampered by failure to receive complete returns from the field, the Population Division had accomplished by July 1 all that reasonably could be expected. During this period the Committee had several conferences with the officials of the Bureau in regard to the form of the bulletins and reports for population, but the final form of the state bulletins could not be determined until the October meeting.

During the last half of 1920, the schedule provided that the Population Division should reach its maximum size; that the editing of the schedules and the punching of the population cards should be finished; that the verification of the cards by the tabulating machines should be completed; that the total population of the United States should be announced; that a start should be made in the publication of bulletins giving the population by minor civil divisions; that preparations should be made for the first and second runs of the population cards and this work started; that the form of the tables for the bulletins giving the composition and characteristics of the population should be fixed. It was also planned to begin in this period the publication of preliminary figures giving the analysis of the population by color or race. The schedule further provided for organizing during this period the force required to edit the schedules for the census of occupations; establishing the form of the card to be used; and starting the work of punching these cards.

Much of this work has been completed and it seems probable that the remainder will be accomplished by the end of the period, but in justice to the Bureau the Committee desires to call attention to the unusual difficulties attending the organization of the force of clerks and operatives. There seemed to be a scarcity of persons qualified and willing to do the work. Special arrangements were made with the Civil Service Commission to hold examinations in the Bureau at Washington, and appointments were made without delay.

The Bureau's records show that to operate the punching machines day and night in the Population Division required about 1,600 people. To operate the machines in the Division of Agriculture required about 1,100 people. To appoint this force of 2,700 operators the Bureau communicated with 9,333 persons eligible for appointment. Of this number 391 declined to consider the appointment, 1,730 neglected to answer the inquiry, and 2,190 were rejected for various reasons. A total of 5,022 appointments were made during the period from March 1 to September 1, 1920.

This indicates an excessive turnover in the force, which added materially to the difficulties and expense of the work. Clerks and operatives would report for duty, work a few days, and resign. This was due in part to the prevailing shortage of labor, but especially to the low wages paid by the Bureau for this class of work as compared with wages then obtainable in the industrial world. When the Committee met on May 28, this situation had become so acute that to assist the Director to meet it, the following recommendation was adopted:

> "The Committee regrets to learn of the continued difficulty in securing adequate output from the pantagraph punches. Since the whole success of the Census, from the standpoint of prompt accomplishment of its work, rests primarily upon speeding up this initial process, the Committee strongly recommends that a new system of employment and payment be established for the night shift and, if advisable, also for the day shift. Under this new plan such increased compensation should be offered, up to 60 cents a hundred, as will attract competent and steady workers. These temporary workers should be employed outside the Civil Service classification and without any of the privileges (sick leave, etc.) customary for the permanent employees of the Government.
>
> It is the belief of the Committee that a careful comparison of the cost of the present service, unsatisfactory because of its large labor turnover and small output, with an efficient service at largely increased pay, would show under present conditions the real economy of higher wages.
>
> In any case, it is absolutely essential that the present situation be corrected by prompt and vigorous action. Freedom from Civil Service regulations and an attractive piece-rate are fundamental. The Committee desires to record formally its recommendation that these steps be taken at once."

The Bureau adopted the policy of increasing its piece-work rate of pay for punching the cards. This change worked fairly satisfactorily. It is doubtful if the Director of any earlier census ever encountered more serious labor problems than those encountered by the present Director.

The preliminary count of the population of the United States was announced on October 7, which was relatively twelve days later than the date of the corresponding announcement at the last census. While comparisons in such matters are difficult to make in definite terms, officials connected with both censuses insist that more satisfactory progress has been made at the Fourteenth than at the Thirteenth Census, because during this period other branches of the work were carried to a more advanced stage.

Most of the errors in the census are due to defects of enumeration, such as the omission of individuals or incorrect replies. The term of employment of the supervisors and enumerators is too short for them to understand the work thoroughly and to appreciate the importance of a strict compliance with the regulations prepared for the purpose of assuring the enumeration of every individual. In some cases the enumerators will neglect, through oversight or carelessness, to enumerate certain portions of their districts; in others, persons residing within corporate limits will be enumerated outside the limits, or those outside will be enumerated within the limits. In some cases supervisors neglect to appoint enumerators for certain districts. In others they do not give the close supervision necessary to ensure thorough enumeration.

To reduce these errors to a minimum, the Bureau, at the Fourteenth Census, early solicited the coöperation of chambers of commerce, boards of trade, and public-spirited citizens throughout the entire country. These organizations and persons were requested to coöperate with the supervisors and enumerators, and, if they believed that a careless enumeration was being made, to call the facts to the attention of the supervisor, or to communicate directly with the Bureau at Washington. As a further precaution against errors of omission, arrangements were made to publish the preliminary totals for all cities, counties, and minor civil divisions just as quickly as the data could be assembled and to send copies of these preliminary statements to chambers of commerce, boards of trade, and other persons for the purpose of verification. This practice has resulted in the correction of many errors such as, it is believed, crept into prior censuses and were never detected.

While the vast majority of the complaints of defective enumeration proved upon examination to have slight foundation, there were a number of instances in which the Bureau after checking the work of the enumerators added considerable numbers to the population of cities and townships. This was the case in Richmond, Va., Birmingham, Ala., Gainesville, Fla., Kansas City, Mo., and Pueblo, Colo. In some cases the mayors of the cities and representatives of the civic organizations made an independent canvass of their cities, listing the names of all residents. These lists were brought to Washington by the city representatives and compared with the returns of the enumerators. The persons found on the new lists but not on the original schedules were subsequently visited by sworn enumerators and, if eligible for enumeration, included in the population of the cities.

By this policy the Bureau not only reduced the margin of error in its statistics of population but also secured the coöperation of local authorities in safeguarding its work—contacts that should prove helpful to the Bureau at subsequent enumerations. The Joint Committee regards this policy as a marked improvement, which should become a permanent feature of census taking.

Agriculture

In the Division of Agriculture it was planned that during the last six months of 1919, the schedules, forms, and instructions should be established and printed; publicity work should be conducted to familiarize the farmers with the scope, purpose, and value of the statistics of agriculture; lists of irrigation and drainage enterprises required for the field force should be prepared; arrangements should be made for the purchase or lease of all mechanical equipment for punching and tabulating the cards; the schedule and card files should be constructed and systems of filing worked out; forms of tables should be established and figures for the census of 1910 entered; and the general plan and scope of the bulletins and reports should be established. Except for the detailed plan of the bulletins and reports all of this work was finished within the period named.

The work planned for the first half of 1920 was to complete the enumeration, make a preliminary examination of the schedules as they were received from the enumerators; carry on correspondence looking toward their completion and toward the further instruction of supervisors and enumerators who were doing inefficient work; complete the instructions for clerks who were to edit the schedules; organize a force of approximately 400 clerks required for editing; complete the instructions for punching the cards and organize a force of approximately 1,100 clerks for this work; install 70 sorting machines and 61 tabulating machines; establish the forms of result slips upon which the data from the tabulating machines are entered; begin the publication of preliminary totals for counties; publish a bulletin showing the number of farms by states and counties; and arrange for the publication of preliminary press announcements of the totals for counties.

The Division of Agriculture was able to maintain its schedule with but one exception. Since the farm schedules were secured by the enumerators for population the delay in the appointment of the enumerators retarded the completion of the enumeration of farms. This delay made it impossible to publish the bulletin on the number of farms until October 7, 1920.

At the Thirteenth Census two bulletins on agriculture were issued for each state, of which the first apparently was printed to meet the urgent demand for prompt publication of results and contained data on practically all the subjects covered by the schedule. The second bulletin contained additional details concerning the same subjects and text consisting largely of a repetition of the figures in the tables. For the Fourteenth Census, in accordance with the general policy agreed upon by the Bureau, it was decided to publish but one bulletin for each state and to confine the text to essential explanatory matter. This arrangement has not only eliminated duplication, but has also made possible a more logical and compact presentation of the data. A considerable saving in expense has been effected and at the same time an earlier date secured for the publication of the final report.

The schedule for the last half of 1920 was as follows: To complete the editing and preparation of the schedules for the card punching; bring the number of operatives up to the required maximum; keep all of the sorting and tabulating machines in operation during the entire period; begin the publication of state bulletins on agriculture; issue the first of the series of preliminary announcements of statistics of agriculture by states and preliminary statistics of irrigation and drainage.

The first preliminary statement was issued on June 1, 1920, for Cheatham County, Tennessee. The first bulletin was issued on September 22, for New Hampshire. Up to November 1, the Bureau had published 228 county press summaries for agriculture, 139 for drainage, and 157 for irrigation, and sent to the printer copy for four state bulletins. The preliminary examination of schedules was completed on July 21, and the editing of schedules on August 4. The punching of cards for the census of agriculture, originally scheduled to be completed by June 30, 1921, will be completed in December, 1920. The work of this division appears to be well advanced.

During the first half of 1921 it is planned to complete the tabulation of the cards for the census of agriculture, publish the bulletins for most of the states, and make substantial progress in the preparation of the tables for the final report.

Manufactures

The field work of the census of manufactures differs from that of population and agriculture in that returns are secured by mail so far as possible. Where this is not possible, special agents secure the schedules by visiting the plants.

At the beginning of the census period a large proportion of the experienced employees of the Census Bureau were in the Division of

Manufactures. It was necessary that these trained employees should be utilized to instruct supervisors and to act as supervisors in districts where vacancies occurred. This necessarily postponed the date on which the field force of the Division of Manufactures could be completely organized, and retarded the completion of the enumeration.

The Division of Manufactures planned to complete during the last half of 1919 the list of the names and addresses of the manufacturing establishments and of the central offices from which a number of separate plants are managed; prepare all schedules and instructions; divide the United States into convenient districts for the field force; prepare the schedules to be mailed to the manufacturing establishments; select the special agents for the field work; and begin the organization of the field force.

The program for the first half of 1920 was as follows: Mail schedules; organize the field force and the clerical force; make preliminary examination of the schedules received; organize the editing force; decide upon the methods of tabulation; close the enumeration in certain districts; and, if possible, begin issuing preliminary statistics for cities.

The Committee learned at the meeting in November that the field work of the Division of Manufactures had been greatly delayed by the difficulty of securing and retaining the services of competent field agents. This was due to the low salary permitted under the law, $125 per month being the maximum. Fourteen hundred agents were needed, but by July 1, in spite of every effort on the part of the Division, only 1,000 were at work. In some places, notably in Detroit, the appearance of a business-like representative of the Bureau in the office of a corporation needing clerical assistance led to attractive offers of immediate employment. These offers were often accepted on the spot and it is difficult to exaggerate the embarrassment of the field supervisors deprived of valuable special agents and unable to fill their places. By reason of this rapid turnover it was decided not to incur further expense and delay by continued effort to secure and train additional men, and the Division proceeded to carry through the field work with the limited force at its disposal on July 1.

The plan for the last half of 1920 contemplated completing the enumeration; editing all the schedules; organizing the force for this work. By the close of November the field work of collecting the reports was practically finished, but the last of the outstanding schedules will not come in before the end of the year. The method of tabulation has been decided upon, and the punched card system will be used for the first time in this branch of census work. All of the blanks required for the work have been prepared. A start has been made in issuing preliminary summaries of results. Such statements have been published for the District of Columbia and Hawaii.

At the present time the Committee is advising with the Bureau as to the form of tables and the character of text to be included in the bulletins and final reports of the Division of Manufactures.

FOR THE AMERICAN STATISTICAL ASSOCIATION:
WILLIAM S. ROSSITER, Chairman,
CARROLL W. DOTEN,
EDWIN F. GAY.

FOR THE AMERICAN ECONOMIC ASSOCIATION:
WALTER F. WILLCOX,
WESLEY C. MITCHELL,
EDWIN R. A. SELIGMAN.

December 1, 1920.

APPENDIX

Recommendations Made to the Director of the Census by the Joint Committee of the American Economic and the American Statistical Associations to Advise the Director of the Census.

40. Incorporated places which are primary civil divisions, with the population figures, will be retained in the minor civil division table, but other incorporated places will be included in that table only by name (*e.g.* Prattsville, including Prattsville town).

41. The Committee recommends that population by wards be omitted from the minor civil division table and that a separate table be included to show population by wards for 1920 only for cities of 5,000 inhabitants or over, this table to be constructed four columns to the page.

42. The Committee approves the inclusion of two new county tables in the first series of population bulletins which shall embody data that in 1910 were shown in the first part of the county table of the second series. The first of these new tables will show the population from 1850 to 1920, the per cent of increase for the last three decades, and the land area and population per square mile for 1920. The other table, which will be the last table of this bulletin, will show the urban and rural population in 1920, 1910, and 1900, the per cent urban in these three years, the per cent of increase in urban and rural population, respectively, in the last two decades, and the rural population per square mile in 1920. In this last table only those counties each of which contains one or more incorporated places of at least 2,500 inhabitants in 1920 will be shown separately, the totals for all the other counties in a given state, i. e., the rural counties, being given on a single line at the end with a note showing the names of those counties.

43. The Committee recommends that the presentation of data for counties and for principal cities in the state supplement bulletins for population be reduced to a one-page stub, and that the information thus omitted from the state bulletins appear so far as practicable in the report on population by subjects, together with certain of the data already contained in the state supplement bulletins.

44. The Committee discussed with the Chief Statistician for Agriculture his general plan for the tabulation of data secured from the Fourteenth Census farm schedule. The Committee approves the outline and series of tables proposed, but anticipates that minor departures from it may become necessary as the work progresses.

45. The Committee approves of the plan of the Division of Agriculture to publish statistics of number of farms, by counties, for the present census and for the two preceding censuses at the earliest possible date after the completion of the enumeration.

46. The Committee believes that the number of percentages and averages included in the final volumes of the Thirteenth Census was so great as to delay their

publication and accordingly recommends that the figures of this description in the volumes of the Fourteenth Census be greatly reduced.

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47. The Committee recommends—
    a. That all text tables shall be numbered and bear titles.
    b. That Roman numerals be used for numbering text tables and Arabic numerals be used for numbering general tables.

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48. The Committee recommends that its Resolution No. 31g as follows: "To the end that all possible saving of time may be effected, it is recommended that practically all so-called interpretative text be omitted from the bulletins and reports of the Fourteenth Census and that no text be printed in the bulletins and final reports that is not needed to clarify tables or to prevent misconstruction of figures, and that all interpretation be reserved for special studies," shall apply to the preparation of all text in the state bulletins and final reports relating to population, agriculture, and manufactures.

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49. The Committee recommends that cartograms such as were used in the Thirteenth Census be included in bulletins of the Fourteenth Census, where appropriate, providing that the preparation of such cartograms does not delay the publication of a bulletin more than ten days.

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50. The Committee recommends that, in determining the boundaries to be used in reporting the population of any municipality, the Bureau of the Census should follow the limits of that municipality as determined by law, and that, in cases where the census of 1910 did not follow this rule, its figures be amended so as to become comparable with those for 1920, the change to be explained in a footnote.

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51. The Committee approves the following plan, submitted by the Chief Statistician for Population, for classifying foreign white stock:
    a. That the foreign born be classified:
        (1) By mother tongue and country of their own birth, on the basis of the post-war map.
        (2) By mother tongue and country of birth of their parents on the basis of the pre-war map.
    b. That the native born of foreign parentage be classified by mother tongue and country of birth of their parents on the basis of the pre-war map.

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52. The Committee approves the outline submitted by the Chief Statistician for Population, indicating the plan to be followed in preparing the material for the occupations report, and recommends—
    a. That the Chief Statistician for Population proceed as rapidly as possible to edit the schedules and punch the cards required for the census of occupations.
    b. That the Director adopt the policy of publishing the occupations report within the decennial census period and that, if necessary, certain other topics, to be decided upon later, be sacrificed in order to include occupations, the working out of this policy to be determined by the Director in conference with the Advisory Committee at a subsequent meeting.

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53. The Committee approves a plan submitted by the Chief Statistician for Manufactures of reporting data by industrial zones, provided that where so-called

metropolitan districts are recognized by the Division of Population, these metropolitan districts and the corresponding industrial zones shall be coterminous.

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54. The Committee recommends that the Abstract be published in one octavo volume, not to exceed 1000 pages, and that it contain only the more important figures with reference to each of the three general subjects of investigation. The Abstract is not to be a substitute for the general volume on each subject. Further details as to data to be included will be considered at a future meeting.

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55. The Committee, having conferred at length with the Chief Statistician for Population and his expert assistant and with the Chief Statistician for Revision and Results concerning the table form and content of the second series of population bulletins, has approved certain forms submitted for summary tables and advised the incorporation of certain desired items from the proposed forms of both experts. These combined data have been fully considered and approved by the officials and their adoption is recommended by the Committee. It is understood that complete forms as indicated will be at once drawn off by the Bureau and submitted for final approval to the Committee. The forms tentatively approved include a one-page stub for the county table and for cities of 10,000 inhabitants or more, a half-page stub for incorporated places of 2,500 to 10,000 inhabitants, and a one-page stub differing from that used for the counties for the wards of cities of 50,000 inhabitants or more.

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56. The Committee regrets to learn of the continued difficulty in securing adequate output from the pantagraph punches. Since the whole success of the Census, from the standpoint of prompt accomplishment of its work, rests primarily upon speeding up this initial process, the Committee strongly recommends that a new system of employment and payment be established for the night shift and, if advisable, also for the day shift. Under this new plan such increased compensation should be offered, up to 60 cents a hundred, as will attract competent and steady workers. These temporary workers should be employed outside the Civil Service classification and without any of the privileges (sick leave, etc.) customary for the permanent employees of the Government.

It is the belief of the Committee that a careful comparison of the cost of the present service, unsatisfactory because of its large labor turnover and small output, with an efficient service at largely increased pay, would show under present conditions the real economy of the higher wages.

In any case, it is absolutely essential that the present situation be corrected by prompt and vigorous action. Freedom from Civil Service regulations and an attractive piece-rate are fundamental. The Committee desires to record formally its recommendation that these steps be taken at once.

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57. While the Committee approves in the main the bulletin on agriculture for New Hampshire, it suggests that the text, after being curtailed in the manner indicated in the revised form submitted at this meeting, be printed in type smaller than ordinary text type under the title "explanations," such explanations to remain next to the individual tables; and in this connection the Committee calls attention to its general recommendation made in Recommendations Nos. 31g and 48, namely, that all so-called interpretative text be omitted from bulletins and reports of the Fourteenth Census.

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58. The Advisory Committee approves the form and content of the first series of

state bulletins of population as exemplified by the bulletin for Maryland submitted in proof.

59. The Committee, having examined the basic tables of Chapters I, II, III, V, and XV, of the General Report on Population for 1910, reached the following conclusions regarding the corresponding sections of the Report for 1920:

a. In Chapter I (Number and distribution of inhabitants) the Committee recommends that Table 64, relating to counties, be retained, but that a table showing incorporated places be substituted for Table 59.

b. In Chapter II (Color or race, nativity, and parentage) the Committee approves the arrangement of Table 21.

The omission of Table 48 (Indian, Chinese, and Japanese population in cities of 25,000 inhabitants or more) is recommended.

The Assistant Director's suggestion that the detail of Table 46 be reduced to conform to the detail of Table 47 and that the two tables be combined in one table arranged alphabetically by states is approved.

The Committee approves Table 40 in its form in the 1910 volume.

Table 42, with such changes as are necessitated by the separation of foreign and mixed parentage, is approved.

c. The Committee recommends that in Table 21 of Chapter III (Sex) the absolute numbers and the ratios be given for 1920, but that for 1910 and 1900 the ratios only be shown, and the table be presented in half measure. The separation of foreign and mixed parentage is also to be made in this chapter. It is recommended that Tables 26, 27, and 28 be combined in one table, to conform to the revised form of Table 21.

d. With regard to Chapter V (Marital condition) the Committee approves the presentation of marital condition figures for persons 15 to 34 years of age by single years of age.

e. The Committee approves in general the form of the tables in Chapter XV (Dwellings and families).

60. The Committee has considered the statement of the Chief Statistician for Manufactures concerning the progress of his work and the proposed form of the bulletins on manufactures by states. It is gratified to learn that the form of presentation can be readily made to agree with the style recommended by the Committee and adopted by the Bureau for the bulletins on agriculture and population. The Committee invites attention to the original recommendation on this subject (No. 48), which included the publications of manufactures as well as those of population and agriculture. It is understood that the Chief Statistician for Manufactures will submit to the Committee at its next meeting outlines of tables which he plans to utilize in the state bulletins about to be prepared by his division.

61. The tables on "Marital Condition" in 1910 (Census Vol. I: pp. 507–687) describe a situation not very different from that in 1890 and 1900.

Since the marital condition ratios do not change from census to census as greatly as the ratios in occupations and since the occupation tables in 1910 were greatly curtailed, the Committee recommends that if serious abridgement in the tabulation of one field or the other is necessary it should be made in the tabulation of marital condition.

62. The Joint Committee approves the form and content of the bulletin "Agriculture: Delaware" as a standard form for the state bulletins on agriculture and

withdraws that portion of Recommendation 57 which advised the use of type smaller than ordinary text type for reading matter to appear in this series of bulletins. It recommends that the text on wool and mohair be omitted.

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63. The Committee has inquired of the official in charge of Census printing concerning the service likely to be secured by the Bureau from the Government Printing Office in printing and binding the bulletins and final reports of the Fourteenth Census, and is gratified to learn that no serious delays are anticipated. In view of this favorable outlook the Committee recommends that the Director of the Census reach at an early date a definite understanding with the Public Printer concerning the total volume of printing required to present the results of the Fourteenth Census, the time to be allowed for the various operations, and the best method of scheduling the work in order that it may all be produced prior to July 1, 1922.

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64. The Committee recommends that the final reports of the Fourteenth Census be printed in quarto size, and that the weight of paper used in these reports be reduced (at least in all copies issued for general distribution) to 30 pounds per ream, of a size 25 by 38. The use of paper of the weight proposed is regarded by the Committee as an urgently needed reform at this census. It will tend to minimize the inconvenience now experienced by all users of census volumes owing to the weight and bulk of final reports. There appears to be no practical objection to the use of paper of the weight proposed; increased cost per pound, for example, is approximately offset by reduced weight. The Committee considers that minor objections, if any appear, should not be permitted to prevent effecting this change which is certain to prove of great importance to all users of census final reports.

a. The Committee further recommends that if the Director approve of the foregoing recommendation, steps be taken at once by him to secure the coöperation of the Public Printer and, if necessary, of the Joint Committee on Printing, in effecting this reduction in the weight of paper to be used in the reports of the Fourteenth Census.

NOTES

THE MEAN STATURE OF AMERICAN MALES

By Charles B. Davenport, *Carnegie Institution of Washington*

The stature of a person has long been regarded as his most important single measure. From the time when we first walk, up to maturity, we use it as a measure of growth and development. In mature life it influences our standing among men, our vocations, our apparel. Adult stature varies with conditions of development; it is profoundly influenced by heredity, also, and, indeed, forms an important distinction of race. Thus, while the men of the north of Scotland average nearly 70 inches in stature, Japanese males do not much exceed 62 inches. Norwegians at 68 inches contrast with Polish Jews at 63 inches. In general, the "Nordic" population, with its blond hair and blue eyes, is the tallest in Europe; the Apline race comes next; the Mediterranean is still shorter; and the Asiatic races are the shortest of all the main races. In Europe, especially, the average stature of the men of a country has a considerable ethnographic interest.

The population of the United States is now a great mixture of human races—such a mixture as the world has never before seen. It includes Nordics and Mediterraneans, Negroes and Asiatics, and Asiatic-blends from Southeastern Europe. In such a population the *average* stature of males would seem to have little significance because the population is made up of such varied components. Nevertheless, there is an interest attaching to the mean stature of American males if only on account of the insight it gives into the relative proportion of the different racial components of our population. And the change in mean stature of this population from period to period gives a rough index of the racial change.

The selective draft by which our army was raised in 1917–18 gave the first opportunity in half a century to measure an adequate number of American adult males in about the proportions in which they occur in the population as a whole. Over four million males from 18 to 30 years of age were thus measured, and the surgeon-general of the army has in his keeping the records of stature, weight, and chest girth of 2,500,000 of them. The data have been tabulated for the first million draft recruits (ages 21 to 30 years inclusive) and the mean found to be 67.49 inches.

In this average all ages, white and colored, and all European races are lumped. Within the given limits of age, the age-differences of stature are not very significant for our present purpose. The average stature of white and colored is the same within five-hundredths of an inch, if we may judge from measurements made on 1,000,000 men at demobilization. The figure given is merely the average stature of young adult American males in 1917–18.

A natural inquiry is: How does the stature of draft recruits of 1917–18 compare with that of recruits of the Civil War, 1861–64, fifty-five years earlier? The mean stature of 1,104,841 white recruits of the Civil War was, according to Gould (1869, p. 105), 67.64 inches. To conclude that the average stature of our male population has diminished only 0.15 inches would be unjustifiable, however, because the men measured in 1861–64 are not comparable, as a whole, with those measured in 1917–18. First, because the population of Civil War recruits excluded the southern states which were in rebellion, while the population of 1917–18 includes them. Now it is just these southern states that, in 1917–18, show the tallest average stature; and the inclusion in the later data (and not in the earlier) of several states with a mean stature three-fourths of an inch above the average tends to raise unduly the 1917–18 mean stature as compared with that of the Civil War. Second, while relatively few of the first million recruits of the World War were under 21 years of age, there were 351,175 out of 1,104,841, or 31.78 per cent, of the recruits of the Civil War who were under that age. Many men under 21 have not reached their full stature, and the exclusion of such men from the later mass of data tends to raise its average.

A juster basis of comparison of the mean stature in the two epochs is that between the individual states, and accordingly the following table has been drawn up. It is based on Gould's Table I for the Civil War data, and on the Selective Draft data for 1917–18, and reveals a certain measure of stability in the order of average male statures in the different states, even during the course of half a century. In both the earlier and the later series Iowa, Kentucky, Missouri, and West Virginia stand near the top of the list (of these northern states), and Connecticut and Rhode Island at the very bottom. New York, Pennsylvania, and Massachusetts stand low in both series, the effect of the immigration of South Irish and South German stock being already evident in 1861–64. On examining the difference column it appears that there is an increase in mean stature in Minnesota, due to recent Scandinavian immigration thither; Wisconsin shows little change in mean stature because the increase of Scandinavians has counterbalanced the effect of the shorter immigrants. New Jersey's increase

COMPARISON OF STATURE (IN INCHES) OF NATIVE AND FOREIGN-BORN, WHITE AND COLORED DRAFT RECRUITS, UNITED STATES, 1917–18; AND WHITE RECRUITS OF THE CIVIL WAR (GOULD, TABLE I), BY STATES IN ORDER OF 1917–18 AVERAGE STATURES (LOUISIANA OMITTED ON ACCOUNT OF SCANTY DATA IN GOULD'S TABLE)

State	Stature		Difference
	1917–18	1861–64	
Minnesota	68.04	67.63	+.41
Iowa	68.04	68.13	—.09
Kentucky	68.02	68.16	—.14
Missouri	67.95	68.03	—.08
West Virginia	67.87	68.43	—.56
Indiana	67.75	68.06	—.31
Wisconsin	67.60	67.65	—.05
Illinois	67.40	67.97	—.57
Ohio	67.38	67.84	—.46
Maine	67.28	68.12	—.84
Michigan	67.23	67.62	—.31
Vermont	67.12	67.61	—.49
Maryland	67.08	67.31	—.23
New Hampshire	66.97	67.40	—.43
New Jersey	66.77	66.58	+.19
Massachusetts	66.76	67.05	—.29
New York	66.72	67.09	—.37
Pennsylvania	66.72	67.14	—.42
Connecticut	66.71	67.09*	—.38
Rhode Island	66.40	67.09*	—.69

is probably due chiefly to its large commuting population, the overflow of the best of the metropolis which has attracted great numbers of men of exceptionally fine physique. On the other hand decreases in average stature have occurred as follows: Illinois, .57 inch; Ohio, .46 inch; Rhode Island and Connecticut, about .69 and .38 respectively; New York, .37; Indiana, .31; Michigan, .31; Massachusetts, .29. These are the states which have received most of the recent immigration of the Mediterraneans, Polish-Jews, and Balkanese. The great reductions in Maine, New Hampshire, and Vermont are due chiefly to the immigration of the French-Canadians into these states.

To secure the adjusted and more accurate difference between the statures of 1917–18 and 1861–64 by applying the corrections mentioned above, the following formula may be useful:

$$\text{Difference} = \frac{\Sigma[\Delta f]}{F} - J.$$

In this formula, Δ is the difference in the state statures from the table; "f" is the population of the corresponding state in 1910; "F" is the population of the United States proper in 1910; and "J" is the reduction of the 1917–18 stature to be made because of the absence of the juvenile statures included in the 1861–64 data.

Two assumptions have to be made in utilizing the above formula.

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*Data for Rhode Island and Connecticut consolidated, 67.09.

First, that the population of the mountain and Pacific states was negligible at the time of the Civil War, and this involves no great error. Second, that in the southern states no change has occurred in the mean stature of the population between 1861–64 and 1917–18. The latter is, of course, not strictly true. It is true, however, that the change in mean stature of the population of these states has been slight as compared with northern states. A comparison of the statistics of 1917–18 with Coolidge's (1856) army recruiting statistics of 1839–55 suggests an increase in stature for Tennessee, Alabama, North Carolina, and Virginia, and a decrease for Georgia and South Carolina. Little stress should be laid on these differences, however, especially since for some reason in the states where comparisons can be made Coolidge's averages all run lower than those of Civil War recruits taken a few years later. It is probable that the army recruits of 1839–55 were not a fair representation of the male population in respect to stature. Be that as it may, utilizing the assumption just named the value of $\frac{\Sigma[\Delta f]}{F}$ is found to be -0.1799 inches.

The value of "J" is found as follows. From Gould's data (1869, p. 105), recruits under 21 years of age were 0.997 inches shorter than recruits 21–30 years, the exclusive ages of recruits of 1917–18. Such men under 21 constituted 31.78 per cent of the total. Hence, they reduced the mean stature of the 1861–64 recruits by 0.997 x .3178, or 0.3168 inches. Adding the two quantities (0.18 and 0.32) for which correction must be made, we gain as the most probable reduction of mean stature of men 21–30 years old in the United States during the past 50 years, half an inch. This is one physical result of the "new immigration."

A NEW ANALYSIS OF PERSONAL INCOME TAX RETURNS

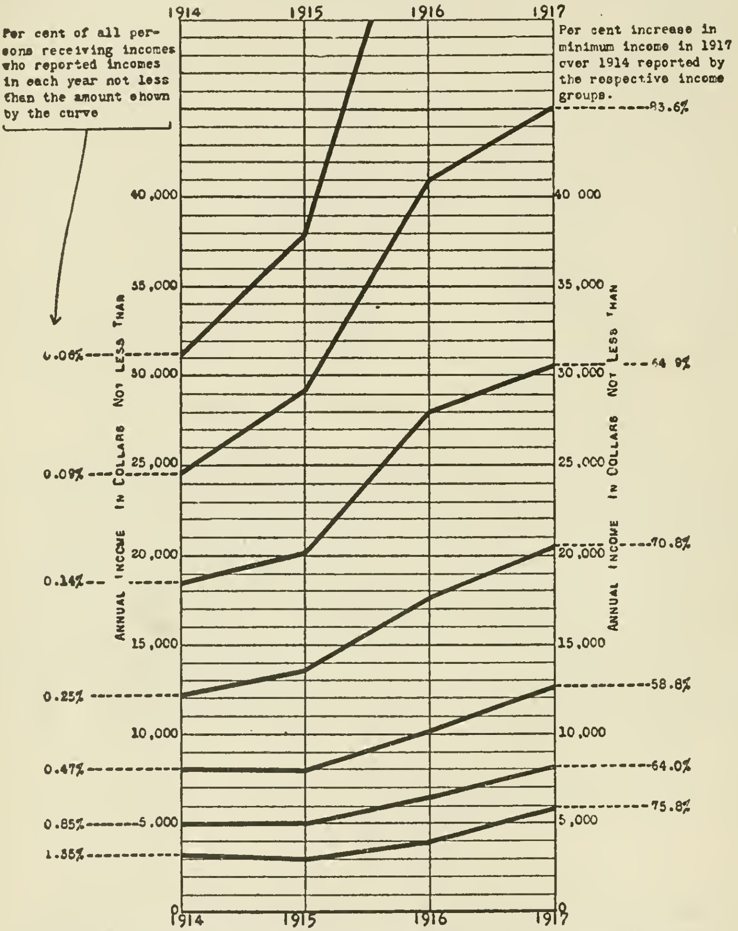
By M. C. Rorty

The accompanying chart represents an attempt to analyze personal income tax returns in such manner as to show the percentages of increase in the larger incomes during the war period. For this purpose, use has been made of the shift from year to year in the dividing lines between comparable groups of income taxpayers. Referring to the chart, it will be seen, for example, that in 1914, .09 per cent of the actual and potential income tax payers (heads of families, etc.) had incomes of $24,700 or more. In 1915 the same percentage of all possible income taxpayers (allowing for increases in population) had incomes of $29,200 or more. In 1917 this percentage of income taxpayers had incomes of $45,000 or more. The increase in the base line for the group had, therefore, been 83.6 per cent during the period from 1914 to 1917.

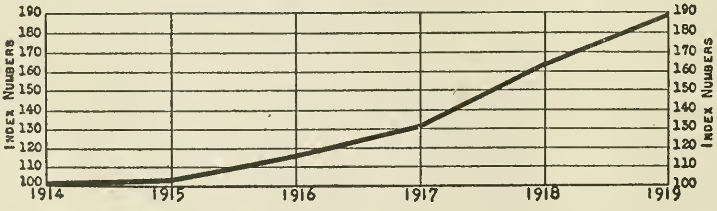
For comparison with the figures as to incomes, there has been plotted at the bottom of the chart an index of wage increases from 1914 to 1919.

TREND OF INCOMES IN UNITED STATES AS REPORTED BY CERTAIN INCOME GROUPS, 1914 - 1917

BASED ON OFFICIAL INCOME TAX RETURNS



INDEX OF WAGES, BASED ON COMPILATIONS OF NEW YORK STATE INDUSTRIAL COMMISSION



It may be expected that, as such charts are carried forward by the addition of figures for 1918 and 1919 personal incomes, there will be, at least in 1919, a downward trend in the income curves, while the wage index will still be rapidly rising. This follows from the fact that the higher incomes are very largely the product of industrial and commercial profits rather than salaries.

When final data for the war period are at hand, it will be desirable to complete the analysis by deducting income taxes from the gross income figures in order to show the final effect of war conditions on the relative net sums available for personal expenditure by the recipients of large and small incomes.

It should be noted, in conclusion, that total possible income taxpayers were estimated for the purposes of the chart by dividing the total population of the continental United States by four. This is a rough approximation, only, but any error involved does not affect the form of the curves.

PROGRESS OF THE POPULATION CENSUS

In the last issue of the QUARTERLY there was a brief statement regarding the progress of the Fourteenth Census. The subject, it may be assumed, is one of great interest to the members of the American Statistical Association, and in response to the Editor's request the following statement has been prepared covering some of the more important features of the work on the population census.

In the tabulation of the population returns the first important step after the schedules have been received and inspected is the hand-count of names. On the basis of this count the population of each state, county, city, and smaller civil division is ascertained and the results are announced as the work progresses. This task was completed about the first of October and on the seventh of that month the Bureau of the Census announced the total population of the United States, 105,683,108. The figures are subject to revision, but there is not likely to be any material change in the total. Comparison with a population of 91,972,266 in 1910 and of 75,994,575 in 1900 shows an increase of 15,977,691 or 21.0 per cent from 1900 to 1910, as against an increase of 13,710,842 or 14.9 per cent from 1910 to 1920, the falling off in the rate of growth being attributable mainly to the almost complete cessation of immigration during the five years preceding the taking of the census.

Following this population count the cards are punched for the detailed tabulation by sex, color, nativity, illiteracy, school attendance, etc. The card punching, which is the largest single task in the population work next to the field work of enumeration, was begun on March 1 and was practically completed by October 1.

The next important step in the process of tabulation is the machine verification of the punched card known as the "verification run," in which the electrical machines are wired so as to reject automatically any card which lacks the required number of punched holes, also any card which is "off gauge," *i. e.*, not punched with the mechanical exactness required for the tabulating machines, and any card on which the recorded data, as indicated by the punched holes, involve some apparent inconsistency, as when, for instance, a card is punched as "widowed" or as "married" and "under 15 years of age." The cards thus rejected for inconsistencies or improbabilities are compared with the entries on the schedules as filled out by the enumerator and, if error is discovered, are corrected. The verification run was begun on the seventeenth of April and is practically completed.

Although this run is, as just explained, primarily for the purpose of eliminating defective or erroneously punched cards, it yields what might be termed a valuable statistical by-product in the shape of an enumeration of the population by race or color, so that on the basis of the results of this run the Bureau is in position to announce the Negro, Indian, Chinese, and Japanese population. These figures, however, are subject to revision. Announcements of this kind have already been made for many of the states and cities. This, it may be added, is something new in census practice as no similar announcements were made ten years ago at this stage of the work.

The first count of the cards, or first tabulation run, shows age groups, illiteracy, school attendance, dwellings, families, and ownership of homes for the population classified by sex, race, general nativity (native and foreign-born), and parentage (both parents native, both foreign-born, one native and one foreign-born). The preparatory sort of the cards for this run—a sort by sex, color or race, nativity and parentage—is well advanced and the run itself has been begun. Readings are taken off for each county, each incorporated city, town, or village of over 2,500 inhabitants and each ward in cities of over 50,000 inhabitants.

The second count or run of the cards will cover the foreign-born white population only, and will give the classification by country of birth. It may be noted that these two runs give all the population detail that will be shown or will be available for counties and for the small cities and villages, since in the later runs the arrangement of the cards by counties is lost and readings are taken off only for the state, the individual larger cities, the smaller cities as a group, and the rest of the state or rural area.

The plans for the publication of the results of the population census provide for two series of state bulletins. The first series, based upon the hand count of names, gives the population of the counties, cities, villages, and townships, and other minor civil divisions, with a classification of the total population of the state as urban and rural and by classes of cities. At this date (December 1) six bulletins in this series have been published and nineteen more are in type.

The second series of state bulletins, based upon the first two counts of the cards, will present data as to race, sex, nativity, age, illiteracy, school attendance, citizenship or naturalization, and number of dwellings and families. The amount of detail to be included in this series has been a subject of careful consideration by the officials of the Bureau and the members of the Advisory Committee, and the results of their deliberations are crystalized in the "one-page stub," which was formulated with the idea of selecting as many of the most important available items as could be brought within the length of a single page. The stub is as follows:

COLOR OR RACE, NATIVITY, AND SEX

- Total population
  - Male
  - Female
- Native white
  - Male
  - Female
  - Native white—Native parentage
  - Native white—Foreign parentage
  - Native white—Mixed parentage
- Foreign-born white
  - Male
  - Female
- Negro
  - Male
  - Female
- Indian, Chinese, Japanese, and all other
- Per cent native white
- Per cent foreign-born white
- Per cent Negro
- 1910: Total population
  - Native white
  - Foreign-born white
  - Negro
  - Per cent native white
  - Per cent foreign-born white
  - Per cent Negro

AGE, SCHOOL ATTENDANCE, AND CITIZENSHIP

- Total under 7 years of age
- Total 7 to 13 years, inclusive
  - Number attending school
  - Per cent attending school

Total 14 and 15 years
  Number attending school
  Per cent attending school
Total 16 and 17 years
  Number attending school
  Per cent attending school
Total 18 to 20 years, inclusive
  Number attending school
  Per cent attending school

Males 21 years of age and over
  Native white—Native parentage
  Native white—Foreign or mixed parentage
  Foreign-born white
    Naturalized
    First papers
    Alien
    Unknown
  Negro
  Indian, Chinese, Japanese, and all other
Females 21 years of age and over
  Native white—Native parentage
  Native white—Foreign or mixed parentage
  Foreign-born white
    Naturalized
    First papers
    Alien
    Unknown
  Negro
  Indian, Chinese, Japanese, and all other
Males 18 to 44 years, inclusive
Females 18 to 44 years, inclusive

ILLITERACY

Total 10 years of age and over
  Number illiterate
  Per cent illiterate
  Per cent illiterate in 1910
  Native white
  Number illiterate
  Per cent illiterate
 Foreign-born white
  Number illiterate
  Per cent illiterate
 Negro
  Number illiterate
  Per cent illiterate
Total 16 to 20 years, inclusive
 Number illiterate
 Per cent illiterate

Illiterate males 21 years of age and over
  Per cent of all males 21 years of age and over
 Native white
 Foreign-born white
 Negro

Illiterate females 21 years of age and over
  Per cent of all females 21 years of age and over
 Native white
 Foreign-born white
 Negro

DWELLINGS AND FAMILIES

Dwellings, number
Families, number

The above detail will be presented for every county and every city of over 10,000 population, and a separate table will give a classification of the foreign-born white population by country of birth. For smaller cities, those from 2,500 to 10,000 population, a half-page stub is to be used showing less detail. It will be several months before this second series of state bulletins will begin to appear, as their publication must await the completion of the second run of the cards.

Regarding the census of agriculture it may be stated, without going into details, that the card punching is about two-thirds completed and the first state bulletin has already been published. A fuller account of progress will perhaps be prepared for the next issue of the QUARTERLY, with some account of the census of manufactures, which has not yet reached the stage of publishing state bulletins, although press announcements are being made.

In general, progress on the census up to date may be regarded as satisfactory. For although the announcement of the total population of the United States was relatively a few days later than in the Thirteenth Census, and the population card punching was not completed quite so soon as it was ten years ago, the beginning of the publication of the first series of population bulletins and of agricultural bulletins is fully three months ahead of the corresponding dates in the census of 1910, allowing for the difference in the dates on which the two censuses were taken, and it is believed that the bulletins will be issued more rapidly than was the case before. The announcement of the total population of the country was delayed in some degree by the unusually large number of complaints and demands for a recount coming from communities where there was disappointment over the fact that the population announced by the census was below expectations and it was claimed that there had been serious omissions. In few instances did these claims prove to be well founded, but the investigation of these numerous cases was naturally a cause of delay.

J. A. Hill.

AN AMERICAN ACCIDENT TABLE

When the National Council on Workmen's Compensation Insurance undertook the task of revising rates for workmen's compensation insurance in the various states, it became necessary for them to calculate the value of amendments to the compensation laws. Up to this time Dr. Rubinow's Standard Accident Table had been used as the necessary basic distribution of industrial accidents. This table was compiled in 1914 and, because very few American data were available at that time, was based almost entirely upon European statistics.

The boards and bureaus having jurisdiction over compensation insurance in the United States felt the necessity of a distribution based on American experience and through their efforts to secure reports compiled on a uniform basis enough material was available in 1919 for the compilation of an American Accident Table. Most of the boards and bureaus having control of the manner in which the insurance companies shall report their workmen's compensation experience now require that such report shall be made on a form known as Schedule "Z." In 1919 Schedule "Z" called for number of fatal, permanent total, permanent partial, and temporary total cases compensated during policy years 1916 and 1917 in each state. The combined reports of all companies showed a total of 271,173 compensatable cases. However, waiting periods vary from state to state and it was desirable that a standard accident table should be based on number of tabulatable accidents, that is, all accidents resulting in disabilities lasting longer than the day or shift during which the accident occurred. Adjustments were made to eliminate the effect of waiting periods and the results, reduced to the basis of 100,000 tabulatable accidents, show 762 fatal, 62 permanent total, 3,788 permanent partial, and 95,388 temporary total cases.

For the distribution showing duration of disability in temporary total cases no information was available except the reports of state industrial accident commissions. The difficulty of coördinating these various records made it necessary to discard many of the reports. However, a total exposure of 475,423 temporary total cases was available. Only two states reported duration of temporary total in permanent partial cases, but the indications followed so closely the tabulation of the Standard Accident Table that the material was used for the purpose of valuing the cost of amendments.

The Travelers Insurance Company of Hartford, Conn., furnished a tabulation of 9,464 permanent partial disabilities from their experience in all states from January 1, 1916, to June 30, 1919. It was possible to combine with this report the reports of the Wisconsin Industrial Commission for 1914 to 1918, so that the combined data showed a total of 12,923 cases. With this as a basis, a table was compiled distributing 3,788 cases of permanent partial disability according to nature of injury.

Schedule "Z" required insurance companies to make an individual report for every fatal accident, stating relationship and age of each dependent. From this information it was possible to compile a distribution of dependents, and also to obtain the average age of such dependents.

The following table shows the results of this study:

General Distribution

Fatal		762
Permanent total		62
Permanent partial		3,788
Major permanent partial	924	
Minor permanent partial	2,864	
Temporary total		95,388
		100,000

Duration of Temporary Total Disability

Temporary Total		*Permanent Partial*	
Duration	*No. Cases*	*Duration*	*No. Cases*
1 day	8,823	1 week or less	206
2 days	8,086	1–2 weeks	171
3 "	7,282	2–3 "	270
4 "	6,014	3–4 "	362
5 "	5,255	4–5 "	380
6 "	4,606	5–6 "	324
7 "	4,807	6–7 "	273
8 "	3,090	7–8 "	224
9 "	3,074	8–9 "	193
10 "	2,740	9–10 "	166
11 "	2,475	10–11 "	141
12 "	2,275	11–12 "	122
13 "	1,868	12–13 "	105
14 "	2,190	13–14 "	92
2–3 weeks	10,925	14–15 "	71
3–4 "	6,269	15–16 "	59
4–5 "	4,345	16–17 "	51
5–6 "	2,674	17–18 "	48
6–7 "	1,923	18–19 "	45
7–8 "	1,298	19–20 "	41
8–9 "	966	20–21 "	39
9–10 "	745	21–22 "	37
10–11 "	549	22–23 "	34
11–12 "	447	23–24 "	33
12–13 "	358	24–25 "	31
13–14 "	296	25–26 "	30
14–15 "	254	6–7 months	79
15–16 "	216	7–8 "	52
16–17 "	182	8–9 "	39
17–18 "	154	9–10 "	29
18–19 "	131	10–11 "	22
19–20 "	110	11–12 "	19
20–21 "	94		
21–22 "	79		3,788
22–23 "	68		
23–24 "	56		
24–25 "	45		
Over 25 "	609		
	95,388		

Permanent partial disability			3,788
Dismemberment or loss of use		2,704	
Arm	61		
Hand	86		
Thumb	96		
One phalange of thumb	152		
Index finger	301		
One phalange index finger	261		
Second finger	147		
One phalange second finger	172		
Third finger	104		
One phalange third finger	89		
Fourth finger	119		
One phalange fourth finger	65		
Thumb or finger and loss of or injury to other fingers	532		
Leg	62		
Foot	43		
Great toe	37		
One phalange great toe	16		
One toe other than great toe	19		
One phalange of toe, not great toe	11		
One toe and loss of or injury to other toes	35		
Hearing, one ear	5		
Hearing, both ears	1		
Eye	290		
Disfigurement		50	
Other permanent partial		1,034	

DISTRIBUTION OF FATAL CASES

No dependents		174
Widow alone		177
Widow and children		253
Widow and one child	79	
Widow and two children	68	
Widow and three children	47	
Widow and four children	28	
Widow and five children	17	
Widow and six or more* children	14	
Orphans		26
One orphan	13	
Two orphans	6	
Three orphans	3	
Four orphans	2	
Five orphans or more†	2	
Widow and other dependents		4
Widow and one parent	1	
Widow and children‡ with other dependents	3	

* Average number of children, 7.

† Average number of orphans, 6.

‡ Average number of children, 2.

Parents and or brothers or sisters		125
One parent	66	
Two parents	35	
One brother or sister	7	
Two brothers or sisters	2	
Three or more* brothers or sisters	1	
One parent and one brother or sister	5	
One parent and two brothers or sisters	3	
One parent and three or more brothers or sisters	2	
Two parents and brothers or sisters†	4	
Other dependents‡		3
Total		762

Olive E. Outwater.

ORGANIZATION OF THE DIVISION OF STATISTICS IN THE MASSACHUSETTS DEPARTMENT OF LABOR AND INDUSTRIES

On December 1, 1919, the Massachusetts Bureau of Statistics passed out of existence and its functions were transferred to other departments of the state. This Bureau, organized in 1869 as the Bureau of Labor Statistics, was the first governmental agency to be established "for the gathering and compilation of statistical data relating primarily to the welfare of the wage-earning classes of the population."§ Other states and foreign countries soon after established similar bureaus, closely following the plan of organization and the methods of procedure of the Massachusetts Bureau.

In place of a Bureau of Statistics Massachusetts now has a Division of Statistics which is included in the Department of Labor and Industries. The Division of Statistics as now organized includes certain of the original functions of the Bureau of Labor Statistics and comprises the following branches:

Labor Statistics, for the collection and tabulation of statistical and other information relating to matters affecting labor conditions and questions of general economic and social interest. The data collected are published in labor bulletins which are numbered consecutively as issued. Each number is devoted to a single subject and at the end of the year they are bound together under the title *Annual Report on the Statistics of Labor*. In addition to the labor bulletins, quarterly reports relative to industrial conditions in the Commonwealth are issued under the title *Massachusetts Industrial Review*. This Review takes the place of the former *Quarterly Reports on Employment* and affords a medium for the early publication of summary data obtained in connection with various investigations, the results of which are published later in greater detail.

Manufactures Statistics, for the collection and tabulation of statistics of manufactures (published annually under the title *Report on the Statistics of Manufactures*),

[*] Average number of brothers and sisters, 4.

[†] Average number of brothers and sisters, 3.

[‡] Average number of dependents, 3.

[§] *The History of Statistics, its Development and Progress in Many Countries*, an article by Charles F. Gettemy, entitled "The Work of the Several States of the United States in the Field of Statistics," p. 692. Mr. Gettemy, who for twelve years served as director of the Bureau of Statistics and under whose direction it was brought to a high standard of efficiency, resigned in July, 1919, to accept a position as assistant federal reserve agent of the Boston Federal Reserve Bank.

and the compilation of an industrial directory (an up-to-date copy of which is kept in the office).

Department Library, a reference collection on industrial and economic subjects for the use of the entire department and the public. This collection includes the large number of publications which had been accumulated by the Bureau of Statistics since 1869 and special libraries of other offices now consolidated in the new department.

Public Employment Service, for the purpose of assisting employers in securing competent help and aiding workers to obtain positions. There are three State offices located, respectively, in Boston, Springfield, and Worcester. The operation of public employment offices was part of the work of the former Bureau of Statistics, and in the absence of a separate Division of Employment the administration of these offices has been assigned to the director of statistics, who acts also as assistant federal director for Massachusetts of the United States Employment Service with which the State offices work under a coöperative agreement.

The work of the former Bureau included also the taking of the Decennial Census of the Commonwealth, now transferred to the Secretary of the Commonwealth,* and the duties of compiling municipal statistics, of auditing municipal accounts and certifying notes of towns and districts, now undertaken by the Department of Corporations and Taxation.†

Roswell F. Phelps.

Massachusetts Department of Labor and Industries.

THE FIRST NUMBER OF *METRON*

The appearance of the first number of *Metron*, the new international review of statistics, is an event in the development of statistical science deserving note. The object of *Metron* is to afford a common *locus* for "original articles on statistical methods and on the application of statistics to the different spheres of activity,"—articles published in the organs of the particular sciences with which they deal and not readily accessible to those interested in the application of statistics to other sciences—"and reviews or discussions of results obtained by statistical methods in various fields of science, or such material as may be of interest to the statistician." It publishes articles in English, French, German, and Italian. "The sole necessary condition of approval for publication is that papers shall make a contribution to the theory or practice of statistics of original value and likely to interest a greater or smaller number of students of statistics."

The first number contains the following articles:

L. March. "La méthode statistique"—a discussion of the foundations of statistical methodology by the director of the French statistique generale, dividing methods of statistical analysis into three categories: (1) comparison of groups of observations by means of centering constants; (2) study of variability within the group; and (3) study of correlations.

E. Czuber. "Ueber Funktionen von Variablen zwischen welchen Korrelationen bestehen." The author derives formulae for the mean and standard deviation of a function of correlated variables. The paper is a generalization of Pearson's formulae for the mean and standard deviation of an index.

F. Vinci. "Sui coefficienti di variabilità"—a discussion of two functions for measuring variability.

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* Massachusetts Acts, 1919, Chapter 350, Section 25.

† *Ibid.*, Section 52.

F. Y. Edgeworth. "Entomological Statistics"—a continuation of the author's studies already published in other places on the average duration of expeditions of wasps from the nest.

C. Gini. "La coscrizione militare dal punto di vista eugenico." Gini shows that conscripts marry later, but have more children than those excused from military service. Military conscription in Italy, therefore, is not necessarily dysgenic in its results.

G. H. Knibbs. "The theory of large population-aggregates." Knibbs points out that constant rate of increase of population cannot continue for long, owing to limitation of natural resources, and that pressure of population is an important cause of war.

G. Zingali. "Della misura statistica dell' abilita dei giocatori nelle corse al galoppo." This novel paper attempts to evaluate, for whatever purposes the reader may care to put the results to, the relative abilities of jockeys performing in the principal Italian racing classics.

J. Bourdon. "La fiscalité de guerre (discussion)"—a general discussion of certain economic problems of the late war.

F. P. Cantelli. "Sulle applicazioni del calcolo delle probabilita alla fisica molecolare"—a résumé of the work of various investigators in the field of molecular physios.

C. Gini. "Ridolfo Livi (1856–1920)"—an obituary of the eminent physical anthropologist with bibliography of his writings.

Altogether it is apparent that if the catholicity of interest and the high quality of the articles in this first number are maintained, the future of *Metron* is assured. The general appearance and the typography of the journal are excellent. There is one editorial matter which should be changed. Following a somewhat general but not universal Italian practice, the author's name is placed at the end of his article instead of at the beginning. From a working bibliographic standpoint such an arrangement is most unfortunate. Whatever, if anything, may be said in its favor in a purely literary journal or review, it has no place in a scientific journal.

An examination of this first number makes it apparent that *Metron* will fill a real gap in statistical literature and will be required on the library shelves of every serious worker in statistical fields.

AN EMPLOYMENT INDEX FOR WISCONSIN

The Industrial Commission of Wisconsin, beginning July, 1920, has been collecting monthly data on employment conditions. There are reporting about 170 employers with over 80,000 shop employees—about 30 per cent of the total number employed in the state—and a weekly payroll of $2,500,000. The data will be handled in much the same manner as it is in the *New York Labor Market Bulletin*. The number of employees and the total payroll will be compared each month, and average earnings will be compared with the cost of living. The Wisconsin bulletin, however, will differ from the New York bulletin in two respects: the material will be presented in a less technical manner, and instead of the retail food price index of the Bureau of Labor Statistics, a monthly cost-of-living index, which will be constructed from the semi-annual cost-of-living index of the U. S. Bureau of Labor Statistics as modified by the monthly changes in the cost of living reported by the National Industrial Conference Board, will be used.

The first bulletin, issued in October, contains two graphs which show the trend of employment since January, 1915. It was possible to secure data as far back as 1915, from employers representing between 15 and 20 per cent of the payroll of the state.

One graph shows total number employed and total wages paid from January, 1915, to July, 1920. During this period the number of employees increased 43 per cent and the total wages paid increased 257 per cent. This graph is in general agreement with the New York one. There is the same sharp drop in number of employees and wages paid during the spring of 1919, the subsequent recovery up to March, 1920, and the gradual decline since that month. The other graph compares average weekly earnings with retail food prices during the same period. Earnings in July, 1920, show an increase of 150 per cent over January, 1915, while food prices show an increase of only 112 per cent.

This work is in charge of A. J. Altmeyer, Chief Statistician of the Wisconsin Industrial Commission, Madison, Wis., from whom copies of the bulletins as issued may be secured.

THE SIGNIFICANCE OF SOME RECENT SMALLPOX STATISTICS FOR THE PACIFIC COAST

Recent statistics of smallpox in the Pacific Coast states will be interesting to members of the Association. In California during 1917, 329 cases were reported; in 1918 there were 1,172, and in 1919, 2,001. In relation to population, the situation in Oregon was even worse. In 1917, 122 cases were registered; in 1918 there were 497; and in 1919, 2,626 smallpox notifications were received by the health authorities. In the state of Washington during 1917 there were 390 cases; during 1918 there were 1,676, and during 1919, 4,369.

Yet, in the face of this great increase in the prevalence of the disease, certain groups in the Pacific Coast communities have this year conducted campaigns for anti-vaccination constitutional amendments in California and in Oregon. Each would take from the constituted health authorities the scant police powers they now possess to control the smallpox menace. In California, the anti-vaccination amendment to the state constitution was so drawn that health officers would not be permitted to keep from schools and other places of instruction and from public offices not only those who had not been satisfactorily vaccinated against smallpox but also those who were actually suffering from a mild attack of smallpox or other infectious disease. The Oregon amendment was even more drastic in its terms. There it was proposed to prohibit "vaccination, inoculation or other form of medication" as a condition of entrance or attendance at any school, college, educational institution, or as a condition of "the employment of any person in any capacity, or for the exercise of any right, the performance of any duty or the enjoyment of any privilege." The amendment would repeal all provisions constitutional, statutory, municipal, of charter or ordinance in conflict with it. As "medication" would, in all likelihood, include any sanitary measure which a health officer might exercise in the performance of his duties, the effect of the passage of this amendment would be to prevent the removal and isolation of any person suffering from smallpox in a lumber camp, or of a child sick with diphtheria and attending school, or of a teacher in an advanced stage of tuberculosis at work among his or her pupils. The advocates of these anti-vaccination amendments have for many years worked covertly, but in the present political campaign they chose to challenge public health work in the open. Both those who were animated by sincere if misguided conviction, and those who profit financially from discrediting public health work, have had the confidence to come out openly for a test of power.)*

There is a strong statistical argument in favor of vaccination. The experience of the people of Cuba is perhaps one of the best examples we have of the efficacy of vaccination. In 1896 and in 1897 there were over one thousand deaths each year from smallpox in the City of Havana alone. With the beginning of American occupation of the island vaccination was enforced; children were compelled to be vaccinated as were also all persons who could not produce satisfactory evidence of previous inoculation. The beneficent effect of this procedure was observed almost at once. Between 1901 and 1917 there was only one death from smallpox in the City of Havana. In Japan a similar condition was observed. Before vaccination was effectively carried out, Japan had thousands of cases and deaths each year. Epidemics of the disease were especially severe. In 1909 a law was passed requiring vaccination of each infant within three months after birth. This measure alone apparently had the effect of greatly reducing the number of cases and deaths. There have been no serious epidemics from smallpox in Japan since vaccination was generally introduced.

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* Since the above was written, the people of California and of Oregon have defeated the anti-health amendments referred to by unmistakable majorities.

Sanitary statistics also show that in the United States and Canada there are no centers of smallpox infection where vaccination has been thoroughly tried out and that no epidemics have commenced in these protected centers. On the other hand, in cities where there is great laxity in the enforcement of vaccination laws, or where there are no laws to be enforced, many cases occur each year. In the Province of Ontario where there has been persistent opposition to vaccination, a very severe outbreak occurred early this year and the United States sanitary authorities declared a quarantine on all travelers from that province into the United States.

It is hoped that members of the Association will interest themselves in the collection of the facts concerning smallpox and vaccination and that they will present this evidence forcefully to their communities. Smallpox will be a serious menace to the health of the people of the United States during the winter of 1920–21. There has been a world-wide increase in the number of smallpox cases. At the port of New York several steamers entering the harbor in the summer and early autumn have been quarantined because of the presence of smallpox on board. It should be recalled that during the war people from all parts of the globe were brought together in large numbers and some came from countries where there is always more or less smallpox. The lack of adequate medical and sanitary service in all of the fighting countries of Europe, the unfavorable living conditions arising out of the war, and the marked falling off of universal vaccination have resulted in an increased prevalence of the disease. At the present time smallpox is a real menace to the health and welfare of the people of the United States and Canada. Members of the Association should do everything in their power to bring the facts of the problem to the attention of their health and educational authorities.

Louis I. Dublin.

MISCELLANEOUS NOTES

The New York City Census Committee. This Committee was formed by resolution of a meeting of representatives of sixty municipal departments and social agencies held at the New York Academy of Medicine, October 2, 1919. It was incorporated "to secure speedy and special tabulation and publication of the Census of New York City, taken as of January 1, 1920, by sanitary districts." Dr. Haven Emerson, former Health Commissioner of New York City, is Chairman of the Committee and Dr. Walter Laidlaw, of the New York Federation of Churches, is its Executive Secretary. The city has been mapped, permanently, into over 3,000 districts, and the Census of 1920 was taken in such a manner as to permit the population of each of these areas to be handled separately and to be grouped into larger areas for specific purposes, as required for educational, health, business, and social needs. The Federal Census Bureau publishers detailed results for assembly districts only, which are political areas, unsuited for other purposes. It is the purpose of this Committee to secure the population data for the small areas and to arrange and publish the results for such groupings as seem most useful. City authorities and others questioned the accuracy of the Federal Census Bureau's count of population in January, 1920, which fell far short of estimates previously made, especially in the case of the Borough of Manhattan which was shown to have actually declined in population. The New York Census Committee appointed the following sub-committee to gather and review available evidence bearing upon the accuracy of the enumeration: Kate H. Claghorn, New York School of Social Work; Frederick B. DeBerard, The Merchants' Association; Louis I. Dublin, Metropolitan Life Insurance Company; Raymond B. Fosdick, New York Federation of Churches; Adna F. Weber, Public Service Commission; Robert E. Chaddock, Chairman, Columbia University. Various lines of inquiry were pursued by this special Committee, and a report was submitted covering the evidence from the growth of transportation facilities, vital statistics, school population, immigration, dwellings, and voting population. Agreement was reached that "the preponderance of evidence seems to indicate that the count was probably as accurate as previous census counts and that the results are not enough in error to invalidate the census." Therefore, in the light of the Committee's findings it would be an unnecessary and unwarranted expense for the city to undertake a recensus of the city or of Manhattan borough.

Foreign Trade Index of the Federal Reserve Board. The need of an analysis of our post-war foreign trade figures has been generally felt for some time past. In order to determine as far as possible the extent to which the increase in our import and export values has been due to price increase, and to furnish certain further analysis of our imports and exports as compared with the year 1913, the Division of Analyses and Research of the Federal Reserve Board has undertaken to prepare and publish monthly what it terms its "Foreign Trade Index," publication having begun in the July *Federal Reserve Bulletin.* The commodities included in this index were chosen largely with the view to practicability of obtaining those goods for which 1913 prices could be had, at the same time, of course, maintaining such a selection as would give a well-balanced sample of our foreign trade. The list of imports included represent 47.7 per cent of the value of imports for 1913, and the commodities of export represent 56.3 per cent of the total export values. The commodities both of import and export are classified as to raw materials, producers' goods, and consumers' goods. The monthly value of the imports of each of these classes and the grand total of all imports and exports included are computed on the average 1913 monthly prices, an index number of such values being then computed on the monthly average of such values for the year 1913. A number of interesting facts relative to changes which have taken place in our foreign trade and to the extent to which we are returning to pre-war conditions as judged by 1913 are revealed by these figures as published monthly in the *Federal Reserve Bulletin.* Perhaps the outstanding feature of the table is the fact that when the influence of fluctuating prices is removed a very decided tendency is shown for our imports to increase, while at the same time our exports have increased in very much lower proportion. During the more recent months, it is true, there is a tendency for both imports and exports to decline. However, this movement is much more marked in exports than in imports. There has been a notable falling off of our exports of raw materials. The value of our exports of these commodities in 1919, if computed at 1913 prices, were about 11 per cent less than in 1913. The figures as published for each month of the current year up to and including August show no tendency toward a return to our pre-war position. On the other hand, our exports of producers' and consumers' goods show a large increase in 1919 as compared with 1913, even when 1913 prices are used. Only in the month of August is there seen any indication of decline in the exports of these goods. With regard to the import situation, it is found that a large increase has occurred in the case of all classes of commodities, the most notable being in producers' goods. And only in the case of raw materials was there any decided tendency toward a decline during the first eight months of 1920. In fact our imports of producers' goods reached their highest levels during January and February of the present year.

Statistical Work in the United States Public Health Service. The statistical work of several divisions of the United States Public Health Service recently has been consolidated into one office. In 1916 a statistical office was established in South Carolina in connection with field studies of the incidence of pellagra in relation to dietary and economic factors, with Mr. Edgar Sydenstricker in immediate charge of the statistical phases of the pellagra studies. In 1917 the studies were considerably extended in their scope and Dr. Willfred I. King became associated in the work, continuing until 1920. When the pandemic of influenza occurred in 1918, certain epidemiological and statistical studies were begun under the supervision of Mr. Sydenstricker and Dr. Wade H. Frost, and the statistical office, established for this purpose in Washington, developed into a general statistical office for the Scientific Research Division of the Public Health Service. Statistical studies were also inaugurated in connection with the work of the Service in industrial hygiene, child hygiene, venereal diseases, morbidity among industrial wage-earners, and morbidity reporting, and in the Hospital Division in which was centered the administration of marine hospitals and hospitals for the care of disabled soldiers and sailors. In 1920 all of the statistical work in connection with these activities was placed under a single supervising head and the various offices, with their personnel, tabulating, computing, and other equipment were housed in the same building in Washington. The statistical staff at present consists of Mr. Edgar Sydenstricker, Statistician, in general charge; Dr. F. M. Phillips, Associate Statistician, industrial hygiene; Mr. Maurice Leven, Assistant Statistician, hospital statistics; Mr. Dean K. Brundage, Assistant Statistician, industrial morbidity; Mr. Selwyn Collins, Assistant Statistician, child hygiene; Miss Mary L. King, tuberculosis; Miss Dorothy Wiehl, pellagra; Miss Mary H. Louden, influenza; and a clerical force. Associated with this staff are Professor Raymond Pearl, of Johns Hopkins University, and Professor Willfred I. King, as consultants, and Drs. Frost, Goldberger, and others in the Public Health Service.

Health Work in American Cities. There is little definite knowledge of the amount and character of the health and vital statistics work which is carried on even in the larger cities of the United States and Canada. Little is known concerning the amount of money expended, the personnel, the various activities that are undertaken, the particular methods of procedure followed, the results that are obtained under the various systems, and new work that is planned. The American Public Health Association, recognizing the great value to the country at large of an accurate knowledge of municipal health department procedure, has appointed a committee composed of Prof. C. E. A. Winslow, Chairman, Dr. Charles V. Chapin, Dr. Wade H. Frost, Dr. Donald B. Armstrong, Dr. Allen W. Freeman, and Dr. Louis I. Dublin, Secretary, to investigate and report on this subject. The Metropolitan Life Insurance Company has placed at the disposal of the Association a sum of $5,000 with which to carry out this piece of work. The Committee has surveyed six of the Pacific Coast cities and in a few weeks will have surveyed six of the eastern cities. With the experience thus gained a final revision of the questionnaire is to be prepared. The health officers already visited have shown a great deal of interest in the questionnaire and have gladly answered the list of questions, realizing that the completed report, based upon a careful statistical study of the questionnaires, will be of value in making available to health officers throughout the country the methods in use in other cities. It is felt that the final report will make for greater uniformity in health department practice and will stimulate the introduction of new activities.

International Conference on Causes of Death. The Third Decennial Conference for the purpose of revising the International Classification of Causes of Death and Sickness was held at Paris during the week beginning October 11. Forty countries were represented. A number of important changes in the classification were made as a result of the deliberations of the Conference. Many of them were made at the instance of the American delegation. In fact, the great majority of the changes and improvements recommended by the American Public Health Association Committee on the Accuracy of Certified Causes of Death were adopted. These suggestions may be found in Reprint No. 440 of the *Reports of the United States Public Health Service.* The delegation from Great Britain, which had also given much study to this subject, made many suggestions which were in agreement with those of the American delegation. Among the most important of the changes in the classification of diseases was the transfer of acute poliomyelitis and meningococcic meningitis from the class of Diseases of the Nervous System to a new class to be known as Epidemic, Endemic, and Infectious Diseases. The Commission also provided for the tabulation of lethargic encephalitis as one of the diseases under the same class. The American delegation was as follows: Dr. Herman M. Biggs, Commissioner of Health of the state of New York; Dr. Rupert Blue, United States Public Health Service; Dr. William H. Davis, Chief Statistician for Vital Statistics, United States Census Bureau; Dr. Haven Emerson, Chairman, Committee on the Accuracy of Certified Causes of Death, A. P. H. A.; Dr. William H. Guilfoy, Registrar of Records, New York City; Dr. F. J. Monaghan, Deputy Commissioner of Health, New York City; Colonel Henry A. Shaw, Medical Department, United States Army; Mr. George H. Van Buren, Supervisor of the Statistical Bureau, Metropolitan Life Insurance Company. Mr. Van Buren attended the Conference as the representative of the American Statistical Association. Dr. Emerson and Mr. Van Buren were the delegates of the American Public Health Association.

Industrial Studies of the Russell Sage Foundation. The Russell Sage Foundation in its Department of Industrial Studies is making a series of investigations of industrial relations, particularly the methods of securing representation of employees. Three studies in the coal industry are now in preparation. These studies have included an inquiry into a plan for representation which is limited to the mines of one company, a study of methods of collective bargaining of the United Mine Workers in the central competitive field, and an analysis of the problems of management which are reflected in the grievances of the miners. Another inquiry in progress deals with the works council of the Rock Island Arsenal. The data gathered have not been primarily statistical, but several interesting statistical problems emerge which relate not so much to the treatment of material as to the lack of basic data. For instance, we are left in the dark about so vital a subject as the normal number of tons of coal dug by a miner in a day, because although official reports show tons produced and numbers employed, it is impossible in an employment so intermittent as coal mining to derive from this the facts about individual output. In short, the problem is to find the method of measuring "unemployment within employment"—the loss of time within a day even when the mine is in operation and the worker is in attendance. The effect on the earnings of piece workers is obvious. Accurate methods of measuring it would greatly clarify negotiations for new wage scales and would point the way, too, toward possible improvements in management. The difficulty in securing basic data is of course not confined to the coal industry. It suggests the importance of more continuous attention by statisticians to the devising of practical records for current use in industry, which shall reveal the information needed in industrial relations. The investigators who have taken part in these studies are Ben M. Selekman, Edwin S. Smith, Hugh Archbald, and Louis Bloch.

The United States Railroad Labor Board is engaged in working out a comprehensive classification of railroad employees. *Report No. 1 of the Wage Series*, published by the Board, shows the average daily and monthly wage rates of railroad employees on class No. 1 carriers. It is hoped that the classification which the Board is now working on will provide suitable forms upon which roads will report wage data to the Board, and will establish a basis for satisfactory wage statistics for railroad employees. This classification will be ready for adoption by the roads about January 1, 1921.

The National Research Council, with headquarters at Washington, has elected the following chairman of its various divisions for the year beginning July 1, 1920: Division of Foreign Relations, George E. Hale, Director, Mt. Wilson Observatory, Carnegie Institution of Washington; Government Division, Charles D. Walcott, Secretary of the Smithsonian Institution, and President of the National Academy of Sciences; Division of States Relations, John C. Merriam, Professor of Palaeontology, University of California and President-elect of the Carnegie Institution of Washington; Division of Educational Relations, Vernon Kellogg, Professor of Entomology, Stanford University and Permanent Secretary of the National Research Council; Division of Industrial Relations, Harrison E. Howe; Research Information Service, Robert M. Yerkes; Division of Physical Sciences, Augustus Trowbridge, Professor of Physics, Princeton University; Division of Engineering, Comfort A. Adams, Lawrence Professor of Engineering, Harvard University; Division of Chemistry and Chemical Technology, Frederick G. Cottrell, Director of the Bureau of Mines; Division of Geology and Geography, E. B. Mathews, Professor of Minerology and Petrography, Johns Hopkins University; Division of Medical Sciences, George W. McCoy, Director of the U. S. Hygienic Laboratory since 1915; Division of Biology and Agriculture, C. E. McClung, Professor of Zoölogy, University of Pennsylvania; and Division of Anthropology and Psychology, Clark Wissler, Curator of Anthropology, American Museum of Natural History, New York.

Dr. G. B. Roorbach, Professor of Foreign Trade, Harvard Graduate School of Business Administration, was sent by the Boston Chamber of Commerce as a delegate to the organization meeting of the International Chamber of Commerce recently held in Paris. The International Chamber adopted a resolution presented by Dr. Roorbach, stating that "The International Chamber urges that the agencies charged with the collection of commercial statistics take immediate steps to secure a greater degree of international uniformity in the classification of statistics and the methods of determining the value and the quantity units used in according them." The new method of classifying the exports and imports of this country, which is to be put in effect on January 1, makes this topic of considerable interest at this time.

Mr. Franz Schneider, Jr., has resigned his position as Assistant and Acting Manager of the Research Department of the American International Corporation to become the Financial Editor of the *New York Evening Post.*

Mr. Seldon O. Martin, Manager of the Research Department of the American International Corporation, has spent the last few months in Europe studying the economic situation with special reference to our future trade there. He visited England, France, Italy, Spain, Central Europe, and Scandinavia.

Mr. Mervin E. Lyle, who for some years has been connected with the Columbia Graphophone Company, is now associated with Mr. Willard C. Brinton, President of the Terminal Engineering Company.

Dr. C. J. West has recently accepted a position in the Department of Agriculture at Washington, D. C., as Specialist in Charge of the Division of Marketing Statistics, Bureau of Markets.

Miss Mignonette Uhl, who has been doing statistical and actuarial work at the University of Michigan, is now connected with the Statistical Department of the Metropolitan Life Insurance Company.

Dr. Leonard W. Hatch, who has been Chief Statistician of the Bureau of Statistics in the New York State Industrial Commission, has just resigned to become Manager of the New York State Insurance Fund. Dr. Hatch's place has been filled by the appointment of Dr. Eugene B. Patton who has been Chief of the Division of Special Investigations since 1913 and who has passed the competitive Civil Service examination set to fill the position at the head of the list.

Dr. Leonard P. Ayres of the Russell Sage Foundation has been elected Vice President of the Cleveland Trust Company of Cleveland, Ohio. Dr. Ayres gives up his work as Director of the Department of Education and the Department of Statistics of which he has been in charge since the establishment of the Russell Sage Foundation.

NEW MEMBERS ELECTED SINCE SEPTEMBER 1

Axe, Emerson W., 195 Broadway, New York City. Statistical Department, American Tel. & Tel. Co.

Benton, Carroll, 195 Broadway, New York City. Statistical Department, American Tel. & Tel. Co.

Berridge, William A., Committee on Economic Research, Harvard University, Cambridge, Mass.

Coe, Richard S., 195 Broadway, New York City. Statistical Department, American Tel. & Tel. Co.

Cogswell, Clarence N., Nat'l Aniline & Chemical Co., 21 Burling Slip, New York. Manager, Sales Research Department.

Craig, Ralph C., Statistical Department, Liberty Nat'l. Bank, 120 Broadway, New York City.

Davenport, Charles B., Cold Spring Harbor, Long Island, N. Y. Director, Department of Genetics, Carnegie Institute of Washington.

Dwyer, C. E., Statistical Department, American Tel. & Tel. Co., 195 Broadway, New York City.

Emerson, K. B., U. S. Census, Division of Manufactures, Washington, D. C.

Foss, Clarence W., Statistical Department, American Tel. & Tel. Co., 195 Broadway.

Frickey, Edwin, Committee on Economic Research, Harvard University, Cambridge, Mass.

Gottschall, M. Hoke, Department of Internal Affairs, Harrisburg, Pa. Chief, Bureau of Statistics and Information, Department of Internal Affairs.

Hoyt, Homer, Statistical Department, American Tel. & Tel. Co., 195 Broadway, New York City.

Ingalls, Walter R., Room 1204, 115 Broadway, New York City. Director, American Bureau of Metal Statistics; Consulting Engineer.

Johnson, William F., Taylor Instrument Co., 95 Ames St., Rochester, N. Y. Employment-attendance records.

Josselyn, M. P., Statistical Department, American Tel. & Tel. Co., 195 Broadway, New York City.

Koukol, C. J., Statistical Department, American Tel. & Tel. Co., 195 Broadway, New York City.

Lee, Ralph A., The Barrett Co., 17 Battery Place, New York City. Special Engineer, Distillation, Coke and Tar Industry.

Mann, Lawrence B., Statistical Department, American Tel. & Tel. Co., 195 Broadway, New York City.

Raibourn, Paul A., Famous Players-Lasky Corp., 485 Fifth Ave., New York. Research work.

Rettig, Hugo V., Statistical Department, American Tel. & Tel. Co., 195 Broadway, New York City.

Rice, Willis B., President, Graphic Service Corporation, 154 Nassau St., New York City.

Schaffner, P. A., Statistical Department, American Tel. & Tel. Co., 195 Broadway, New York City.

Shaw, Joseph P., Jr., Statistical Department, American Tel. & Tel. Co., 195 Broadway, New York City.

Tait, A. Gordon, Head Office, Royal Bank of Canada, Montreal, Canada. Superintendent of Branches.

Veditz, Charles W. A., National Industrial Conference Board, 10 E. 39th St., New York City. Research work on Board.

REVIEWS

The English Bank Restriction and the Bullion Report of June 8, 1810. Reprinted from Sumner's "*History of American Currency,*" with an introduction by Stuyvesant Fish. New York, Henry Holt and Company, 1920. Pp. vii, 136.

Probably no economic happening since the armistice has been the source of such dramatic interest as the fall in our rates of exchange with the various European countries. For a time we heard from all sides that something would have to be done to remedy the situation or else our huge export trade, built up during the war, could not possibly continue. European buyers, it was argued, could not afford to purchase our goods if they were compelled to lay out such unheard of sums of pounds, francs, or lire for United States dollars. Events since the first fall in the exchanges proved the unsoundness of these predictions, for in spite of the continued high price of dollars in terms of European currencies our exports until quite recently showed no decline. In fact the statistics for the fiscal year 1920 show an increase over those for 1919. Even now, however, we come across numerous references to the handicap to our export business caused by the abnormal state of the exchanges. Almost all such predictions are the result of a failure to comprehend the real factors responsible for the present rates of exchange.

When an existing economic condition duplicates the experience of a previous era and that prior experience has been carefully examined and brilliantly analyzed, it is helpful in endeavoring to throw light on present problems to have before us the study made of the events of that earlier age. This accounts for the reprinting at this time of the now classic report of the Bullion Committee of 1810* for an understanding of the conditions that gave rise to that report and of the fundamental principles therein set forth would do much to dissipate the mists that enshroud the present exchange situation in many minds.

In 1797, on account of the drain of gold from the Bank of England, an Order in Council was issued forbidding specie payment until the will of Parliament should be known. Thereafter this restriction was continued by Parliament from time to time so that specie payments were not completely resumed till 1821. For several years prior to the report of the Bullion Committee there had existed a premium on gold in terms of notes of the Bank of England and the exchanges between England and continental points, such as Hamburg, Amsterdam, and Paris, had been adverse to England. The Bullion Committee was appointed to inquire into the causes of these phenomena. The conclusions of the Committee were that both the high price of bullion and the adverse exchanges were the result of the depreciation of the notes of the Bank of England and that this depreciation in turn was caused by the excessive issue of the notes. Resumption of specie payments was recommended by the Committee as the best preventive against the continuation of the excess of bank notes.

The present reprint contains the complete text of the Bullion Report which was included as an appendix to Professor Sumner's *History of American Currency*, published in 1874. The other portion of the reprint is made up of Chapter II of the history and of a brief introduction written by Stuyvesant Fish. In Chapter II Professor Sumner reviews the conditions leading up to the appointment of the Committee, summarizes its findings, and gives a brief account of the parliamentary debates over the report both in 1811 when its conclusions were repudiated and in 1819 when they were overwhelmingly accepted.

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* An English reprint of the Report with an introduction by Professor Edwin Cannon was also published in 1919 under the title, *The Paper Pound of 1797–1821.*

In the hearings conducted by the Committee practically all the witnesses insisted that the adverse exchange rates of that day were due to an adverse balance of trade or of payments. This reminds us of the reasons frequently adduced in explanation of the present rates of exchange between the various European countries and the United States. In spite of this testimony, however, the Committee came to the conclusions summarized above.

Mr. Fish in his introduction refers to this experience in English monetary history as a "forgotten incident of vast present moment." Certainly the fundamental reasonings of the Bullion Committee in explanation of the events of that day are very pertinent in any investigation of the present exchange rates. Just as in 1810 the explanation was to be found in the depreciation of the Bank of England note, so today the low value of the currencies of European countries in terms of United States dollars is to be ascribed primarily to the depreciation of those currencies, of which in turn the chief cause is to be found in the excessive issue of paper money in those countries, although the falling off of production is also a factor of importance. The present case is far more extreme than that of 1810, but the underlying principles are the same. Once these principles are grasped, it is seen why Europeans may continue to buy from us in spite of the high cost of dollars. Dollars cost more in pounds, francs, or lire than under normal conditions, but on the other hand, thanks to the enormous issues of paper currency, more pounds, francs, or lire are available to purchase the dollars, and the increased price of dollars is principally a reflection of the decreased value of the foreign currencies in their own countries as indicated by the increased price of commodities in general within those countries. Of course in making statistical comparisons allowance must be made for the decreased purchasing power of the dollar itself. We, too, have had our inflation.

The manner in which exchange rates tend to reflect the comparative purchasing power of various currencies is illustrated by the statistics following:

COMPARISON OF PRICE LEVELS WITH RATES OF EXCHANGE AT NEW YORK
(AVERAGE FOR THE SIX MONTHS, JANUARY–JUNE, 1920)

Country	Index number of wholesale prices* [1913–100]	Exchange rate at New York			Purchasing power of currency as compared with that of U. S., Jan.–June, 1920
		Mint par	Average of monthly high and low rates, January–June, 1920		
			Actual Rate†	Percentage of mint par	
United States	259			100.0	100.0
United Kingdom	303	4.8665‡	3.73	76.6	85.5
Sweden	349	26.80§	20.57	76.7	74.2
France	532	19.30‖	7.33	37.9	48.7
Italy	605	19.30¶	5.56	28.8	42.8

* *Federal Reserve Bulletin*, August, 1920, p. 842
† *Ibid.*, April, 1920, p. 437 and July, 1920, p. 763.
‡ Dollars for £.
§ Dollars for 100 kronor.
‖ Dollars for 100 francs.
¶ Dollars for 100 lire.

The last two columns of the table show the value of the currency of each country as compared with that of the United States, first, as indicated by exchange rates, and second, as indicated by price levels. Thus in 1913 when exchange between the United States and England was about at mint par, the value of the two currencies, taking into consideration the different gold contents of the standard money in the two countries, was approximately equal; but during the first six months of 1920 the value of the currency of England—no longer on a gold standard—was only 76.6 per cent of that of the United States as shown by the rate of exchange.

Again, looking at the question from the viewpoint of internal price levels in the two countries, it is to be noticed that the increase in prices in the United States between 1913 and the first half of 1920 is represented by the change in the index number from 100 to 259; while the increase in the United Kingdom was from 100 to 303. Or stating the proposition in terms of the purchasing power of the two currencies, in the United States the purchasing power in 1920 was $\frac{100}{259}$ of that in 1913, and in the United Kingdom it was $\frac{100}{303}$ of that in 1913. Therefore, if in 1913 the purchasing power of English currency was 100 per cent of that of the United States, in 1920 the former as compared with the latter was $\frac{\frac{100}{303}}{\frac{100}{259}}$ or 85.5 per cent. This equivalence in the value of two currencies as indicated by their comparative purchasing powers has been called by Professor Cassel their "purchasing power parity." Since the breakdown of the gold standard in European countries these purchasing power parities, instead of the old mint pars, constitute the real normal rates of exchange toward which the actual rates will constantly tend. For instance, if the actual rate of exchange in New York on London were to fall much below the purchasing power parity of the currencies in the respective countries, the effect would be to discourage exports from the United States or to encourage imports, which in turn would cause an appreciation of the rate.

The figures in the last two columns show that for the United Kingdom, Sweden, France, and Italy, considerable similarity in results is obtained whether the depreciation of the value of the currencies of those countries as compared with the currency of the United States is measured by means of exchange rates or of price levels. In all cases, however, except that of Sweden, a greater depreciation is indicated by exchange rates than by price levels. In other words, the actual rates of exchange in New York on these countries during the period under consideration showed a depreciation below the purchasing power parities of their currencies with that of the United States. Such an excessive depreciation of the actual exchange rates may be accounted for in part by certain factors mentioned by Professor Cassel, namely, "distrust in the future of a monetary standard, outselling of the money of a country at any price when foreign credits cannot be secured, export of money in order to evade exorbitant taxes at home, etc."

In addition, however, attention must be called to the fact that the index numbers by means of which the comparison of purchasing powers has been made are not altogether satisfactory for the purpose. These index numbers should be based only upon commodities that are the objects of international trade. It is only commodities of this sort that under normal conditions such as existed before the war may be expected to show the same gold prices in different countries, allowing for differences due to transportation costs and tariff barriers. The numbers used, however, are general index numbers, based upon all kinds of commodities, some of which do not figure in international trade and whose gold prices even under normal conditions might consequently show wide variations in different countries. It may well be the case that the prices of some of these domestic commodities in the United Kingdom, France, and Italy have not increased in the same ratio as the prices of what we may call the international commodities. This would make an index number including such domestic commodities show a smaller increase than would appear if only the international commodities had been used. Under these circumstances, the rate of exchange in New York on London, for example, might be considerably below a purchasing power parity calculated upon the basis of general index numbers without causing any decreased exports from the United States or imports from England, because the international commodities might be just as expensive in England as in the United States, while the comparatively cheap commodities in England might be non-exportable.

In spite of these defects in the index numbers, however, the similarity of the figures in the last two columns is great enough to suggest that the present exchange rates are the result of something more fundamental than a balance of trade or payments, that the real explanation is to be sought in the depreciation of the European currencies as compared with our own currency, and that the principles enunciated by the Bullion Committee are applicable to the present situation. Professor Cassel's theory of purchasing power parities represents a valuable amplication of the theory of the Committee.

William O. Weyforth.

The Johns Hopkins University.

Military and Naval Insurance, June 30, 1919. Bureau of War Risk Insurance, Treasury Department, Government Printing Office, Washington, 1920. Pp. 162.

There has just been issued by the Treasury Department a statistical report compiled by the Actuarial Division of the Bureau of War Risk Insurance under the direction of Mr. William Macfarlane. The document is interesting not only because it is the first official analysis of a large part of our casualties of the World War, but also because it is the first scientific presentation of facts relating to the mortality experienced by one of the most interesting experiments in government insurance which has been tried by any country.

It will be recalled that shortly after we entered the war, the War Risk Insurance Act was amplified in order to accomplish three purposes:

(a) To provide compensation for the soldiers and sailors and their dependents along the lines of the Workmen's Compensation Acts in force for industrial employees throughout the country.

(b) To enable the soldiers and sailors to obtain insurance protection without the payment of the additional war premium which the commercial companies felt compelled to charge in many cases.

(c) To provide a substitute for the pensions which have always followed in the wake of wars in this country and which are proving a financial burden years after the termination of hostilities.*

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*In an investigation which the writer made for the government, the results of which are published as Children's Bureau Publication No. 28, Department of Labor, it was pointed out that in 1916 the government was still paying pensions to 709,572 pensioners.

The changes made by Congress in the act as drawn may serve to prevent its being a satisfactory substitute for pensions, but notwithstanding errors of administration and regrettable errors in system, the act accomplished the purposes set out in (a) and (b).

It was fortunate for the Bureau that its actuarial work was supervised by so capable a statistician as Mr. Macfarlane and although much of the matter presented in the report under review was probably prepared after he had left the Bureau, he is doubtless entitled to credit for the orderly presentation of facts which will prove of use in the future.

It is to be regretted, however, that nowhere in the report appears any statement of the amounts of insurance issued at the various ages or the duration of the policies. These facts are vital to a proper consideration of the mortality by actuaries, for without them no proper idea of the exposure can be obtained. We are unable, therefore, to make a comparison between the actual and the expected mortality. Life insurance students would likewise be interested in studying the persistency of the business, no data for which appear in the report. While some of these facts may have been contained in fragmentary announcements from the Bureau, the necessity for bringing them together with a statement of the mortality experienced is apparent.

Throughout the report the lack of weighted averages is noted. Although it is interesting to know that there were 77,814 privates involved in death and disability cases under contract and automatic insurance and that there were only 54 colonels, much valuable information is lost by the failure to include a statement of the mean number exposed in each rank. Nowhere in the report is there any attempt to supply these aids to valuable comparisons.

Future users of this report should bear in mind that the insurance death group will represent only a fraction—about 90 per cent it is stated—of the total deaths due to service, for all men who were killed were not insured; the compensation death group does not supply this deficiency because compensation is payable only to beneficiaries within a limited permitted class and in addition to this, such beneficiaries, when they do come in within the limits of that class must, with the exception of wives and children, prove dependency before they are entitled to an award.

An ideal arrangement would be a joint publication by the Adjutant General's Department and the Bureau of War Risk Insurance. This would enable the statistics of the actual mortality experienced by our fighting force to be used to advantage.

The pamphlet must be studied as a whole, but some of the interesting facts (although trivial in some cases) are indicated hereafter. In Table IV, showing the age of the insured and the date of death or the date of disability, it is interesting to note the preponderance of deaths between the ages of 20 and 32. It is pointed out that the average age of the 104,485 who died was 25 years and 4 months, the median age was 24 years and 8 months and the modal age about 23 years. These statistics of course cannot be compared with those of any other country engaged in the war, for our participation required the use of those who were called to the colors by the first draft only. As the largest part of our army, therefore, was called between the ages of 20 and 30, it is but natural to expect that the point of maximum incidence of mortality should be low.

The relationship of the beneficiaries to the insured will prove less interesting to the statistician than it will to the legislator in the future and to the student of ethics. Table V shows that in the 99,625 death cases under contract insurance, the mother was named as beneficiary in 46,375 policies or over 46 per cent, and in 17,640 cases the father was the beneficiary. In nearly 65 per cent of the death cases, therefore, the father or the mother had been selected as the beneficiary, a fact which is both an indication of the unmarried condition of our armed forces and also a tribute to their filial devotion.

Table VI is of particular interest to insurance offices, for in it the death and disability losses are grouped by policy amounts. Of the 100,070 cases involved, 84,155 were $10,000 cases. As the 100,070 cases covered insurance amounting to $919,339,380, it will be seen that the average policy is well over $9,000. In pre-war days, the average death loss of insurance offices was between $2,000 and $3,000, and it is interesting to note that the war or the War Risk Insurance Act or both may be responsible for the fact that the average amount of the insurance policy issued today by commercial companies is very much higher than before the war. Quite unconsciously, perhaps, the government has increased the average, and soliciting agents have not been slow to avail themselves of the psychological effect induced thereby.

The effect of the influenza epidemic on mortality is indicated by the fact that while from October, 1917, to June, 1919 there were 105,050 deaths, during October, 1918, 42,871 deaths occurred, and during September, October, and November, 1918, 67,319 deaths occurred. This same situation is reflected in the table analyzing the deaths by causes, for 18,448 died from influenza and pneumonia and 27,234 from pneumonia and empyema. Of these deaths, 74 per cent of the combined influenza and pneumonia deaths occurred during the epidemic which for statistical purposes is considered as having existed during September, October, and November, 1918, only. The complete list of traumatisms and diseases which caused the deaths and disabilities is illuminating. Bearing in mind that the total deaths and disabilities insured under contract or automatic insurance were 105,050, it will doubtless surprise many to learn that 41,132 were killed in action or died as a result of their wounds received in action; the control which the medical corps exercised over preventable diseases is illustrated by the fact that only 209 deaths are ascribable to typhoid fever and 67 to syphilis; tuberculosis is subdivided as follows:

Tuberculosis, meningitis	72
Tuberculosis, lungs	1,397
Tuberculosis, all other (except Pott's disease)	212
Pott's disease	1

Of all diseases of the respiratory system, only 2.04 per cent can be ascribed to pulmonary tuberculosis. Advocates of the prohibition movement can find little material for argument in the number of deaths traceable to alcoholism, the statistics being as follows:

In the Army		*In the Navy*	
Privates	38	Seamen	3
Corporals	3	Petty officer	1
Sergeants	2		
Captain	1		
Lieutenant-Colonel	1		

Surely this is a record of an exceedingly moral fighting force.

Fifty-eight per cent of the deaths covered by contract insurance occurred in France in which country 40,142 were either killed in action or died from wounds received in action. As the total deaths in all countries ascribable to that cause were only 41,062, the point of fighting intensity is apparent. In the analysis of deaths by countries, it is interesting to note that two deaths from excessive cold occurred in the United

States, one in the British Isles and one at sea. None, however, is charged to North Russia and Siberia.

In the early part of this review regret is expressed that no statistics as to the total insurance were published. On page 115 of the pamphlet, the Bureau states that owing to the constant lapsing and reinstatements, it is impossible to make any statement regarding the liabilities of the government for this fluctuating body of policyholders. It is believed that in general actuaries will be disinclined to admit the inability of the government to calculate its liabilities in this important development and that in the near future a valuation of this kind should be attempted.

All of the foregoing refers to the claims under insurance contracts. The part of the report dealing with claims for compensation benefits is interesting, but the exposure is too meager to permit many valuable deductions to be made. Between October 6, 1917, and June 30, 1919, 243,660 claims for compensation were received on which awards were made for only 58,127; 66,283 were disallowed and the balance, 119,250, or about one-half of the claims received, were reported as "pending." Nearly all of these marked "pending" are claims concerning which more information is required in the form of certificates, affidavits, etc., and the small number of settled cases prevents the publication from being of much interest for statistical purposes.

In view of the experience with insurance policies, one might question the correctness of the statement that of the total number of claims—58,127—only 5,899 have been caused by influenza and pneumonia. The explanation, however, lies in the fact that these claims cover not only death but also disability, and of all claims arising from disability, less than 1 per cent can be ascribed to influenza and less than 2 per cent to pneumonia. S. H. Wolfe.

Census of Religious Bodies, 1916. Bureau of the Census. Part I, Summary and General Tables (594 pages). Part II, Separate Denominations: History, Description, and Statistics (727 pages).

"This report was prepared under the provisions of the permanent census act, approved March 6, 1902, as amended by the act of June 7, 1906. Its purpose is to present statistics of the number of organizations, members, etc., of the different religious denominations of the country, and to give in addition a review of their historical origin and development, their doctrine, policy, and their missionary, educational, and philanthropic activities. The statistics relate as near as may be to the close of the calendar year 1916, and were collected for each local church organization."*

The appearance of another Census of Religious Bodies is always of interest to sociologists and other students of religious groups in the United States. Beginning as a small and not very efficiently managed part of the censuses of 1850, 1860, and 1870, this inquiry first assumed importance in 1890 when the questions asked were as follows: organizations, church edifices, and seating capacities; halls, school houses, etc., and seating capacity; value of church property; and communicants or members. A statement was added of the number of ministers in each denomination as a whole. The census of 1906 added certain new inquiries: the year of establishment (local church organization); amount of debt on church property, number and value of church parsonages; language in which services are conducted; salaries paid to ministers; sex of communicants or members; and the number and membership of Sunday schools conducted by church organizations.

The census of 1916 has somewhat widened the scope of this type of study, principally by separating and expanding the inquiry about ministers; by asking about other buildings used for church work; expenditures of church during preceding year; the sex and church membership of Sunday school scholars; and the number of church members under 13 years of age. The questionnaire about ministers is so explicit that it seems worth while to include it here:

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*Part I, p. 11.

1. Name of minister, priest, or rabbi.
2. Denominational connection.
3. Location.
4. Name, location, and denomination of the churches which you are now serving.
5. State whether pastor, associate or assistant pastor, supply, emeritus, retired, etc.
6. Total amount of salary received during the past year for church service.
7. If in other than pastoral or preaching service, state occupation, and position.
8. Date of ordination.
9. Date of entrance on present pastorate.
10. Age at last birthday.
11. State whether graduate of college or of theological school.

The data of this report were gathered mainly by correspondence with the local church organizations, generally through the pastor or clerk, the list of church organizations having been gathered from year books, etc., of the respective denominations. Special agents collected statistics for sixty-eight denominations and in ten cases a combination of special agent and correspondence was employed. It is noteworthy that 62.7 per cent of the 227,487 schedules were secured through correspondence alone, 30 per cent through correspondence and the work of special agents, and 7.3 per cent through agents alone. The statistics of ministers were secured by direct correspondence with them. Undenominational and union Sunday schools were reported by the International Sunday School Association; figures of church activities were obtained by correspondence and from printed reports; and the historical and doctrinal summaries of Part II were passed upon by responsible members of the several sects.

A valuable feature, first introduced in this census, is the inquiry as to members under and over 13 years of age. The noticeable variability displayed in the matter of juvenile membership is only one of the evidences of the individualistic tendencies of American life, whether regarded in the secular or in the sacred fields. Of the total number of members 87.2 per cent are 13 years of age or over. This fact should be kept in mind in estimating the potential value of the church as an effective medium of opinion or factor in reform.

These two volumes are a mine of examples to "point a moral," at least, if not to "adorn a tale." Not the least interesting is the fact that in the period 1906–16, there was a net increase of fourteen denominations; in 1890–1906, a net increase of forty-one. In the later period fourteen new denominations appear to have sprung up, and in the earlier, no less than forty-eight, not including those added by an amoeba-like proliferation. Do these facts mean that our period of standardization in religion is approaching? Do they indicate that geographical isolation is decreasing, and with it mental isolation and exclusiveness?

In a similar way the figures show that the number of church organizations increased very much less rapidly in the period 1906–16 than in the period 1890–1906, the percentages being 7.2 and 28.5 respectively. The expansive tendencies of the nineties are counter-balanced by the concentrative policy which conditions have forced on many denominations, or which the modern tendencies to coöperate and to avoid duplication have produced.

Membership, however, has increased slightly more rapidly than the number of organizations. For the total period 1890–1916, the membership rose from 21,699,432 to 41,926,854, a gain of 93.2 per cent. From 1890–1906 the increase was 13,368,626, or 61.6 per cent; while from 1906–1916 the increase was 6,858,796, or 19.6 per cent. The increases in the case of individual churches are found in some cases to follow the same trend. For example, the Roman Catholic Church gained 114.1 per cent in twenty-six years, 93.5 per cent in the first period, and 10.6 per cent in the second. Its proportion of all church membership being at the three censuses 33.8 per cent (1890), 40.5 per cent (1906), and 37.5 per cent (1916), it is obvious that the rate of general change is partly conditioned by the trend of this one widely distributed church. Many reports of individual denominations are, however, vitiated by lack of clarity in the original definition of "member"; the Jewish congregations suffer by comparison here.

The question of the sex distribution of members is of special interest at this time. There is no doubt that most denominations could be gynocracies, provided the female members could (and would) seize the reins and rule by majority power. Of the total reported in this connection (about 36,000,000), 56.1 per cent were female. A slight change from the figure of 1906 (56.5 per cent) is here to be noted.

The crucial factor in any church is the clergy thereof. They at once represent the church and guide it. Facts concerning the quality of the rank and file of the membership being unavailable, we look to the discussion of the ministry to throw light on the the church. In all, 191,796 ministers were reported. Of these, 100,793 returned schedules, 95,702 giving fairly complete details.

The first table to strike the attention is that of classification of ministers in church work. There are engaged in pastoral work 80,435. Of these, 64,899 are in pastoral work only—67.8 per cent of all reporting; 6,735 are pastors with other occupations. Of the 15,267 not in pastoral work, the "retired" are 6,702, the others being in denominational, educational, or evangelistic work, or in other occupations.

So much attention is being paid to salaries in these days of rising costs of living that it is important to note that "in only thirty-one of the 104 denominations with five or more ministers who reported salaries was the average salary over $1,000, leaving seventy-three in which it was less than that amount. Specifically, the average salary for these thirty-one denominations was $1,278, while the average salary for the seventy-three denominations was $738. The pastors in these thirty-one denominations numbered 39,970, or 62.9 per cent of all the pastors reporting full salaries, while the lower average salary was reported by 23,573 pastors or 37.1 per cent."* These salary deficiencies are only partially mitigated by free parsonages and retiring allowances, both of which are on the increase.

The statistics of languages used in services cast some light on the value of a *laissez faire* policy in reducing the adherence of foreign groups to their respective native tongues. Giving the approximate percentages for 1906 and 1916 we have:

Using a Foreign Language

1906	1916
11.6 per cent of organizations	11.5 per cent of organizations
26.6 per cent of members	27.0 per cent of members

Using Only a Foreign Language

1906	1916
67.9 per cent of all organizations using any foreign language at all	44.6 per cent of all organizations using any foreign language at all

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*Part I, p. 73.

It is evident that the English language was making great inroads upon the exclusive use of a foreign tongue long before it was found necessary to ban one of the principal languages spoken by the foreign-born of our country. The natural influences were succeeding in producing an effect which will be interesting to compare with that of the more robust methods of 1917 and beyond.

A section of the report that is of great significance is that upon the "Work of Denominations in Domestic and Foreign Fields." It shows in a very concrete fashion how largely the religious bodies of today maintain their activity in fields that have been to a large degree secularized. The data for this part of the report were secured from the general church organizations, not from the local units. The range of information afforded by this section is indicated by the list of subjects treated: in the domestic field, contributions, number of home missionaries, number of higher schools, philanthropic institutions and their beneficiaries, value of property and endowments held for educational and philanthropic uses. Similar information is given regarding the work of the churches in foreign countries.

The reader of this report is likely to be disappointed in one respect, however. The schedules sent to the local church organizations and those sent to the ministers were not completely utilized. For example, in the schedule for churches the date of organization of the local church is asked for, yet no report is given on this topic. The summary of these answers would be very valuable in showing the periods in which church expansion was most rapid; it would offer a sort of record of church natality. In the case of the schedules sent to the ministers similar omissions of treatment have occurred. The questions not dealt with are: date of ordination; date of entrance upon present pastorate; age at last birthday; statement of graduation from college or theological school. (Incidentally, why should not a minister have graduated from both types of educational institutions? Many of them have done so.) A statistical summary of each one of the above named inquiries regarding the individual clergyman would have been valuable. In studying a professional group one is interested in the length of time its members have been practicing the profession. The "labor turnover" of the local church would be measured roughly by the average length of time served at the present position. Whether the clergy are being recruited at a normal rate from each generation would be shown by a study of their age distribution. And certainly the partisan as well as the critic is entitled to know what the educational qualifications of the ministry are. It would be very pleasing to have at least a brief supplementary report published by the Bureau of the Census covering these omitted items in the questionnaire.

C. E. Gehlke.

Western Reserve University.

Statistics of Income. Compiled from the returns for 1917 under the direction of the Commissioner of Internal Revenue, Washington, 1919.

For the purposes of a review of such a report as this, three general questions may perhaps be distinguished as of primary interest: (1) Is the statistical material adequately exploited with reference to setting forth what is of greatest interest? (a) Are the tables and text, as to form and content, what the critical statistician would expect? (3) Are there weaknesses in the data of a nature to impair their usefulness or make it necessary to qualify indicated conclusions?

(1) The reviewer's judgment—which of course is not so good as that of one who has attempted to make actual use of the data—is that the original material has, within certain limits, been adequately exploited in the published tables.

One suggestion seems called for. The size classification for personal returns is by $1,000 steps up to $15,000 (with a $2,500 stage intervening); then by $5,000 steps to $30,000; then by $10,000 steps to $100,000; then by $50,000 steps to $300,000; then by $100,000 steps to $500,000. Then occurs stages of $750,000, $1,000,000 and $1,500,000. And finally the size classes are by even millions up to $5,000,000 and over. The reference is especially to Table II. The classification is condensed in some cases, but appears in the state tables as well as in those for the United States as a whole. The stages might be made to come more consistently at regular geometrical intervals, but the arrangement is not bad. The writer's suggestion is that a more detailed classification would be desirable, though only for the United States as a whole, and perhaps only for net income. Steps of $500 would not be too fine for a large part of the scale, and the smallness of the number of returns in many of such classes should not prevent employing for the country as a whole the finer subdivision. It is to be presumed that the work of compilation was done by means of perforated cards, hence such a table would involve little additional expense.

Since income received from corporations, though deducted for tax purposes, is included in personal returns, the completeness of the report is not, for general purposes, directly affected by the limited space given to corporate data. A separate report on corporate income statistics, as a matter of further compilation, is an important desideratum. The need is not adequately met by the report on "Corporate Earnings and Government Revenues," issued by the Treasury Department as of July 5, 1918, and relating to some 60 per cent of the corporations reporting over 15 per cent earned on their stock in 1917.

(2) Very little space is devoted to text and derivative tables, 19 pages out of the 133 contained in the report being so used. This is appropriate at least as regards emphasis. It would seem, however, that, by way of interpretation, the Income Tax Law and Regulations, as a controlling factor in determining the character of the available data and the form their presentation must take, should be explained in proper relation to the figures. It is true that it is easy to find such information elsewhere, and indeed most readers will have had some little practical experience with the basic schedules and with the questions of classification and definition involved. Under the circumstances, explanatory text of the nature indicated need not be considered absolutely essential.

(3) Some attention might well have been given to the consistency of the compiled data with other sorts of available statistical information. All possible tests of correctness should be applied, not merely on grounds of scientific interest, but also for fiscal reasons. Much of what is desirable in this connection can be achieved by comparison of figures for successive years. The 1916 figures are obviously not directly or entirely comparable with those for 1917. Doubtless more time is necessary for the suggested comparisons and tests. The considerations mentioned are not a direct answer to the third question stated above; and perhaps it is in the nature of the question that it cannot as yet be answered except in a very limited way.

There is an inconsistency between Tables III and X on income classes between $150,000 and $400,000.

With regard to the intrinsic interest and analytical possibilities of the material presented, nothing more than scattered hints should be expected of a reviewer. Moreover, the most fruitful analytical possibilities must await until similar data for a series of years are available.

It is now possible to determine the conformation of the curve of income distribution in the United States with a high degree of definiteness. Comparisons between the states in this respect also suggest themselves.

For moderate and large-sized incomes, information as to their composition as between service income and property income is now available for the statistical student. He will find need for the exercise of considerable acumen in splitting business incomes between services and property.

That the ratio of income from property to total included income increases as the size of incomes increases is an obvious fact that statistics can merely make numerically precise. As a corollary from this fact and with the aid of assumptions with regard to the element of reward for personal services among incomes of very large size, it may be inferred that the number of millionaires in the United States is not much smaller than the number of persons with incomes of $60,000 a year or more, or in 1917 not much fewer than 14,562. At $60,000 the proportion of income from personal services and business is about one-third of the total (p. 14). The share of the State of New York in the above stated number of incomes of $60,000 or more is 4,793 (pp. 48–50).

The data of corporate returns offer a variety of statistical difficulties and possibilities that should attract the analytical student, although for the student of corporate earnings and business conditions the data presented will not be sufficient. Some information is found in the report under review regarding income of Americans from foreign investments and vice versa. Details by kinds of industry from which corporation incomes are derived are presented and should afford much material of statistical interest. It is scarcely necessary to mention the great extent to which the presentation of data separately by states is carried, as this is to be expected in United States Government reports.

This document devoted to statistics of income is the initial report of its kind. It should be the first of a regular series of such reports and the fiscal as well as the public interest in statistics of this nature warrant any reasonable extension of the scope of the compilation and analysis. Fiscal and practical interests do not preclude but are rather dependent upon the presentation of the facts that are of interest to the scientific statistician. G. P. Watkins.

Business Research and Statistics. By J. George Frederick. New York, D. Appleton & Co., 1920. Pp. 333.

Mr. Frederick's aim, as stated in the preface of his book, is both to direct the attention of business executives to the value of business research and to correct the "narrow, circumscribed and uncreative attitude" of the average research worker or statistician, "unacquainted with practical business aim and necessity." The author has added a new set of classifications of statisticians, namely, statisticians, hack statisticians, and business research statisticians who are only "partly professional," being more concerned in advancing the fortunes of their business than winning fame among their professional colleagues.

The book makes no contribution to method in business research, confining itself almost entirely to an enumeration of questions and problems to which business research should address itself, and to the discussion of their practical value. At first glance, therefore, one would say that statisticians would derive little benefit from its perusal. There are, however, several features of the book that are worthy of attention by professional statisticians.

In the first place, the book indicates the development taking place in the field of commercial research under private auspices, which is a matter of considerable significance. The professional statistician, to use the author's phrase, is probably unaware of the nature and extent of this research work which has come about in response to a specific need on the part of business organizations. As the author repeatedly states, such business research deals with specific questions raised by the practice of the business technique and is emphatically practical, being concerned with finding answers to those questions. Its utilitarian character may incline some persons to dismiss it as a mere application of statistical method to money-making and therefore of little scientific value. But such a dismissal would be to ignore several exceedingly important facts which should not be neglected. Either this business research will continue to be only "partly professional," or it will develop into a scientific inquiry into business methods and activities. If ever it is to become scientific, the professional statisticians must turn their attention to it and by criticism and the development of better methods make it so. And when regarded properly, it is impossible to see how they can fail to devote more time and consideration to business research, for it is through such business research that the approach must be made to many economic studies. The data for these studies are collectible only through business organizations and trade associations, since business men will not coöperate with public or academic agencies of study (unless they see some benefit to be derived therefrom), but work with their own agencies. Also, the financing of these economic studies is possible now only through business organizations.

Furthermore, the character of the data being and to be collected for business research is such that the professional statistician cannot afford to neglect this field. Sooner or later the trained statistician will have to concern himself with the larger aspects, at least, of the question raised by the practice of the business technique. For what the business man is seeking is to control economic activities and he demands of business research the answers to the questions of how to do it. Although this interest in research may appear as just money getting, yet in reality the research is more than that: it is an attempt to exercise direction and control over economic affairs through the use of intelligence, an enterprise which must command the allegiance of every statistician who is not wholly blinded by the traditional formulae of economic theory. Even if the professional statistician questions the self-interest of the business man in commercial research, he cannot remain indifferent to the questions it addresses. The questions of demand and its variations, of prices and their fluctuations, of production and distribution are all relevant to the statistical economist. And it cannot be too often emphasized that progress in science has been more rapid when attempts were made to solve specific problems than when complete theoretical structures have been sought.

For the economist the book is of interest since it discusses a variety of questions on or beyond the "frontier of economic theory," questions concerning economic activity which are entirely ignored by the text-books of economics. Until economic theory, predicated upon the concept of a free play of economic forces, reconciles the existence of the large measure of control exercised by business men with its free play of forces, its analysis must be deficient.

Therefore, it is safe to say that although technically the book makes no contribution to statistics as such, it offers a challenge to both statisticians and economists. It is full of inconsistencies, many of which are amusing. For example, in speaking of the labor problem, the author remarks that "business research, *unbound by economic theory*, and trained to think of facts as they are today, would unquestionably have uncovered this grave error long ago (of regarding labor as a commodity)." Yet in discussing the development of manufacturing by wholesalers and jobbers (instead of sticking to their function of distributing only), the author speaks of this as a "cancer spot in the distributive situation today," implying that it is contrary to economic theory and therefore unsound for a wholesale business to develop its own source of supply. Again he says, "the tendency of the larger (distributive) units to cut prices (because they can afford it through securing quantity prices) is a highly unfair and uneconomic proceeding," implying that economic proceedings must favor the smaller unit, probably in order to preserve the competition and the individual initiative dear to the economist's heart.

Also, the author's insistence upon the advisability of having business research done by outside agencies instead of by a private staff in the business implies that scientific work cannot be done by the private staff, which is absurd when one considers the number of chemists, physicists, and engineers now attached to business. It appears too much like a sales argument, other examples of which mar the book.

On the whole the book is more for the business man than for the professional statistician who will, nevertheless, find it valuable as serving to acquaint him with the character of the problems business is studying today, about which he must sooner or later know more than he does.

Lawrence K. Frank.

New York City.

Budgets of Families and Individuals of Kensington, Philadelphia. By Esther Louise Little, A.M., and William Joseph Henry Cotton, A.M. A thesis for the Degree of Doctor of Philosophy at the University of Pennsylvania. Lancaster, Pa. The New Era Printing Co., 1920. Pp. 273.

Since the cost-of-living investigations made by Engels, it has been customary to classify such studies as extensive or intensive, according to the number of cases included. Whether or not such a differentiation is now justifiable, this report will be classed as an intensive study, as it includes only 34 budgets of which 23 are of families, 9 are of unmarried women, and 2 are of unmarried men. The budgets are from actual records kept day by day for a year or a large part of a year, during 1913 and 1914, that is, just before the beginning of the recent upheaval in prices. The investigation also includes a study of incomes, and standard budgets are drawn up for textile-mill workers which the authors designate as a "fair standard of living," the descriptive title thus varying from other such designations as the "minimum-of-subsistence budget" or the "health-and-decency budget."

The study of only a few cases has the advantage of enabling the investigators to know them well. This knowledge the authors have achieved and the basic material is presented in considerable detail, both in summaries and in family histories. The presentation is interesting to read. The accounts are very human. The lists of expenditures for clothing by items, for instance, make a vivid impression. An excellent feature is the showing of the amount of income week by week in curves for each individual. These curves are by no means smooth and the frequent deep downward slopes from the rather low level seem to have almost terrible significance. The details of some of the miscellaneous expenditures are very welcome, as this part of the budget is frequently neglected. The general pattern of the study is somewhat like those of the well-known investigations of Chapin and of More. And it is important to have a few more carefully kept records to add to the not too large existing stock.

Although the fulness of the exposition of the original data is admirable, there are some shortcomings in certain aspects of method. The intensive study of a few cases is often praised for the accuracy attained, but it also presents abundant opportunities for making improvements in method and for obtaining information difficult to obtain when a larger number of cases are studied less thoroughly. Have the authors utilized these opportunities? And have they made any contributions to the development of the technique of cost-of-living studies? In reference to these questions the following comments are made.

The importance of food expenditures in the budget is admittedly great. The food should be listed in quantities and a chemical analysis should be made, showing not only calories but the various constituents. This the authors have not done, although the technique for such a procedure has been well worked out and it could have been done for these few families without much effort. Instead the authors price in Philadelphia one standard dietary worked out for Fall River, Mass., and make comparison with the food expenditures of the particular families. Food is the pivotal point in determining the subsistence budget. It is of greatest value for health and for the growth of children. It is very important that adequate analysis should be made of food consummation.

The great need in studies of standards of living is not so much estimates in prices as in quantities, and qualitative descriptions. For instance, such a quantity budget is intelligible at all times, while a price budget is difficult to understand with the shifting of general and special prices that take place. The thing that tells us what the standard is is the quantity and quality of the items and not the prices, though in some cases prices give a rough indication. This point is particularly applicable to this study made in 1913–14 and published five years later after prices had changed radically. With the small number of families, the authors might have presented more of their estimates in quantities and descriptions.

It would have been feasible, also, to make a more intensive study of fuel than was done. It is desirable to know the fuel consumed expressed in the British Thermal Units in relation to temperatures, kinds of houses, and types of heating apparatus. Such information regarding the relation of fuel to such varying factors was needed, for instance, by the Fuel Administration during the war. Such information would help in determining objectively fuel needs.

In summarizing the data the authors might have made improvements, and indeed should have avoided some defects. In the first place, twenty-three families are almost too few cases to summarize; they form too small a sample to be of much statistical significance. Furthermore, the constitution of these families is so varied that it is difficult to make comparisons. For instance, a family with boarders and lodgers is not the same sort of unit as a family with only husband, wife, and children. If the selection of cases had been made on the basis of a more rigidly defined unit, the results would have been more amenable to statistical treatment. Indeed, it appears that the authors are guilty of sins of commission as well as omission in such a case as the following. Family number 22, which includes a man, boarder and lodger, spent $338 for food which includes the cost of the food the boarder ate, and $36.40 for clothing which does not include the cost of the boarder's clothing. This is all right. But in reckoning the total expenditures of the family, the cost of the boarder's food is added in but not the cost of his clothing. The question is: What is the size of the family whose total expenditure is $555.20? Furthermore, the percentages of expenditure for various classes of items are computed. Thus 60.88 per cent goes for food including the boarder and 6.56 per cent goes for clothing not including the boarder. Now a per cent is a part of a whole, but what is the whole? Is it the expenditure of a family of three individuals or of four? Percentages are supposed to facilitate comparisons, and in the adjoining column of the table referred to another family spends 40.14 per cent of the total expenditure for food; but the family that spends 60.88 per cent has a boarder. What does the percentage comparison mean?

In Chapters II and IV the investigators set forth a standard budget, calling it a "fair standard." The setting of a standard is more difficult than recording what families actually spend, because it involves values and is peculiarly liable to subjective influences. It is interesting to know that the authors set $1,069.94 as the yearly expenditure at a fair standard of living for a textile-mill worker's family of five, consisting of father, mother, a girl of 10, a boy of 6, and a boy of 4 in 1913–14 in Kensington, Philadelphia. But one wishes to know the objective basis for calling it a "fair standard" and an account of what a "fair standard" is in some terms other than the classes of items. There are any number of standards of living. They could be plotted in a series. But why is a particular one singled out and called a fair one? A listing of concrete items does not make it a "fair" one. It might be "fair" to the authors but not to the reader or to some other investigator. There should be some objective tests upon which there would be common agreement, as when we say the temperature of a room should be kept in winter at 68 degrees Fahrenheit. The reader feels a certain confidence in the authors' standard because he sees that the authors are very familiar with the life of the community. But this is not an objective basis. It is certainly too much to expect at the present stage of the evolution of budget studies to arrive at a thoroughly objective standard, and the authors should not be particularly criticized for this failure since no investigator, so far as the reviewer knows, has made much of a success in setting such objective tests for a standard budget. But such a step in the evolution of budget studies is very much to be desired.

In summary it may be said that this study of family budgets furnishes a great deal of very satisfactory detail and that it is a welcome addition of apparently carefully collected data; but its presentation is not particularly expert, nor does there seem to be any significant contribution to methods not already well known and in use at that time.

William F. Ogburn.

Official Yearbook of the Commonwealth of Australia. Statistics for Period 1901 to 1918, No. 12, 1919. Prepared by G. H. Knibbs, Commonwealth Statistician.

Australia's official yearbook is a statistical institution with which the members of this association are familiar. The issuance of the most recent volume bringing the statistics up to 1918, however, affords an opportunity for a brief notice. A general survey of the subjects covered in the yearbook makes one envious of the possibility of canvassing so vast a field in one volume, even though it be a volume of 1,234 pages. The volume, furthermore, is not confined to statistics, but contains a large amount of data on all phases of economic and social life of Australia. Continuity between the volumes for successive years is maintained by publishing every year special articles on various topics and printing in each issue a list of the previous articles with references. Consequently the possession of the latest volume of the yearbook enables the reader to obtain all the statistical data about Australia and gives him in addition a valuable list of references on the topics discussed in previous years.

One reason for Mr. Knibbs' ability to cover so many phases of Australian life in the compass of one volume is brought out by the population map which emphasizes the familiar fact that only the southwestern portion of the continent is at all thickly inhabited, so that the area to be covered is much smaller than the continent. It is of interest that the total population of Australia in 1918 was only slightly over 5 millions and that about 96 per cent of that population were natives of Australia or the United Kingdom, while the total proportion of persons of non-European origin was less than 1 per cent. The great contrast in this respect between the United States and Australia impresses an American statistician. Having always controlled immigration and encouraged only arrivals from the home country and of similar stock, Australia has preserved a homogeneity unequaled by any other colonial territory. Australia is not only a white man's country but a Britisher's country, and this fact has had a decided influence on her institutions and economic development.

The volume contains an excellent map of Australia prepared with the assistance of the commonwealth meteorologist. Many interesting charts are also included in the yearbook. A chart on page 140 shows the growth of the population in Australia, separately for each sex, from 1860 to 1918, as compared with the rate of increase in the United States from 1790 to 1860. Presumably this rate of increase for the United States is chosen as representing approximately the period of development through which Australia is now going. It is of interest that up to 1895 the Australian rate for males was similar to the United States rate, but since that date it has been falling very far behind. On the other hand, in the case of the females the Australian rate did not fall behind the United States rate until 1914, and it is still not very far behind. This increase in the female population reflects the change from a pioneer country to a settled country. As a matter of fact, Australia contains now more women than men, the excess of women being about 1.67 per cent. In 1859 Australia's population was a little over one million and in 1918 it was about five millions, the greatest increase occurring during the first thirty years of settlement. Maximum immigration is recorded during the five-year period 1881–85, at which time it reached 224,000. Since that time it has been on a decline; for the five years 1911–15 the number was 100,000; for the period 1916–18, however, owing to the departure of many Australians to the battlefields, a net loss through emigration of 136,000 is shown. The total increase through immigration from 1861 to 1918 is 770,000.

Australia's deliberate policy of maintaining racial unity at the cost of slower development is the outstanding fact in a survey of its statistical record.

E. A. Goldenweiser.

Special Tables of Mortality from Influenza in Indiana, Kansas, and Philadelphia, Pa., September 1–December 1, 1918. Department of Commerce, Bureau of Census, Government Printing Office, 1920. Pp. 181.

These tables, which were prepared under the supervision of Dr. William H. Davis, Chief Statistician for Vital Statistics, and with the coöperation of the United States Public Health Service, constitute an important body of material for statistical analysis of mortality caused by the pandemic of influenza in the United States in the latter part of 1918. The detail in which the special tabulations were made was the result of numerous conferences on the part of an inter-departmental board representing the medical and statistical offices of the Army, Navy, and Public Health Service, and of suggestions from others who are interested in the epidemiology of the disease. It is the most voluminous and detailed mass of mortality data on this subject that has been made available at any one time in this country.

The chief value of the tables lies in the material which they afford for analysis. No attempt has been made in the bulletin to present analyses of the data, with the exception of a few summary tables and graphs showing the mortality rate among persons of different ages and sexes in certain larger cities in Indiana and Kansas, and in Philadelphia, for the two states as a whole, and for rural portions of the two states. The fact that the population estimates according to age, sex, occupation, and geographic division, as well as for other groups and classes of population, were of doubtful value, rendered any attempt at detailed or refined analyses impracticable. The population estimates for 1918, as is well known, are uncertain because they were too far away from the preceding census. The serious disarrangement of the ordinary distributions of population according to sex, age, occupational, and other groupings caused by the unusual conditions prevailing during the war was another factor which undoubtedly accounts for the absence of more detailed analyses of the data presented. To some extent these handicaps have been overcome by using the proportionate mortality method; but for obvious reasons the results are not so satisfactory as could be desired.

The bulletin, therefore, will become more valuable as soon as the final figures are announced for the census of 1920. Then more dependable estimates of the various population groups can be made and the material can be used in more detailed as well as more accurate ways.

The value of the bulletin lies in the raw material which it offers for statistical analysis. The deaths from influenza and pneumonia are given in considerable detail according to age, sex, occupation, month of occurrence and broad occupational groups. It creates an excellent precedent for the publication of special bulletins giving in sufficient detail for statistical analysis the number of deaths from epidemic and other important causes. For more than one reason, therefore, it is an important contribution to a statistical literature.

EDGAR SYDENSTRICKER.

United States Public Health Service.

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THE BEST FORM OF INDEX NUMBER*

By Irving Fisher

What index numbers are "best?" Naturally much depends on the purpose in view. First let us narrow the question.

Index numbers differ chiefly in: (a) the character and number of data entering into them; (b) the sources and agencies used for collecting the data; (c) the frequency of calculation; (d) the "base" chosen; and (e) the mathematical formula used.

Only the last named, the formula, is here considered.

How widely do index numbers calculated by different formulae differ? Which is (or are) the best?

It occurred to me that new light might be shed on these questions by calculating various index numbers proposed, utilizing the new historical data of the War Industries Board for the years 1913–18.

For this calculation, I have selected thirty-six staple commodities for which complete data, not only for prices, but also for quantities, are given.

The total value of the thirty-six commodities exchanged in 1913 was $13,105,000,000, and in 1918, $29,186,000,000, as obtained by multiplying the prices by the quantities and adding. These figures show an increase of money values in the ratio of 13,105 to 29,186, or of 100 to 223. This 223 per cent is, therefore, the index number of *money value* in 1918 as compared with 1913 as a base.

Our problem is to find how far this ratio of 223 per cent is a matter of inflated prices and how far it is a matter of increased quantities (volume of trade).

It is clear that there can be no ambiguity as to the 223 per cent itself, the index number of money value. There is only one index number of value—the value itself.

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* Professor Fisher's paper, read at the Eighty-second Annual Meeting of the American Statistical Association (Atlantic City, N. J., December, 1920), has not yet been completed in all the detail desirable for publication. Hence only an abstract is printed at this time, together with the discussion that took place at the meeting. The full paper with diagrams and data will be published later.—Editor.

It is only when we try to resolve this 223 per cent into two factors, one the index number of prices and the other the index number of quantities, that we find a bewildering multiplicity of methods. We ought, it would seem, to be able to find a form of index number which, when applied alike to prices and quantities, will give results which check up with the 223 per cent in value.

There are a dozen "tests" which we should like to have an index number fulfil. Eight of these are discussed in my *Purchasing Power of Money*. C. M. Walsh's book, *The Measurement of General Exchange Value*, is chiefly on certain tests of a good index number.

But I have come to the conclusion that there are two supreme tests which, practically at least, carry with them the rest:

I. The formula should *work both ways* as to the two factors, prices and quantities.

II. The formula should *work both ways* as to time.

Thus, as to test I, the formula should, as was said, be such that the two figures it yields when used for calculating the index number of (a) *prices* for 1918 and (b) *quantities* for 1918 will, if multiplied together, give the correct figure, 223 per cent, which represents the index number of *value*.

Again, as to test II, the formula should be such that, if used for calculating, say the index number of prices (a) for 1918 in terms of 1913 as a base and (b) for 1913 in terms of 1918 as a base, the two results will be consistent (*i. e.*, will be reciprocals of each other).

The *simple arithmetic* index number meets neither test.

Thus, the arithmetic index number, when applied to prices, would make it appear that, in 1918, the price level was 187 per cent as compared with 100 per cent for 1913; when applied to quantities it would make it appear that quantities had increased to 126 per cent of what they were in 1913.

But if these two figures are multiplied, we obtain not the true index number of money value of 223 per cent as we should, but 236 per cent, which is too high. The harmonics would give a result too low.

Again, suppose bacon is twice as high in 1918 as 1913 while rubber is the reverse—twice as high in 1913 as in 1918. According to the simple arithmetic index number these two commodities were in 1918 $\frac{200\%+50\%}{2}=125\%$ of what they were in 1913, and at the same time were in 1913 also 125 per cent of what they were in 1918. Each year's price level is 25 per cent above the other's!

In reference to the second test, it may be shown that certain index numbers, including the arithmetic, have an *upward bias*, and others, like the harmonic, a *downward bias*.

It is also true that methods of weighting will introduce a bias. Thus, if the weights used are the values of the *base* year, they impart a *downward bias* to all the index numbers of any given year calculated thereby; while, on the other hand, if the weights used are the values of the given year itself, they impart an *upward bias.*

The reason is, to take the case last mentioned, that the value used in the weighting necessarily contains a relatively high price factor for every high price ratio, and a low for a low. The higher the prices, other things (the quantities) equal, the more they are weighted. It is true that "other things" will not be equal; *i. e.* that the *quantity* element in the weights will have an influence. But this influence is about as likely to be in one direction as the other. This factor, unlike the price factor, is not very definitely correlated with the price ratios which they help weight.

Therefore, the quantity element is of comparatively little consequence in the weights of an index number of prices (or the price element in the weights of an index number of quantities). If I may say so, in an index number of p's we do not need to mind our p's and q's both, but we do need to mind our p's; and vice versa for the index number of q's.

To illustrate, we recur to the bacon and rubber. Suppose that the quantities of bacon are the same in 1913 and in 1918 and the quantities of rubber are likewise the same. It follows that the value of bacon in 1918 was double that in 1913, being proportional to its price and, contrariwise, the value of rubber in 1913 was double that in 1918. To fix our ideas, let us suppose that in 1913 the value of bacon was two million dollars, while in 1918 it was four million dollars, and that the values of rubber were, reversely, three million dollars in 1918 and six million dollars in 1913.

It follows that, with 1913 as a base, the weighted arithmetic index number for 1918, using the values of 1918 (4 for bacon and 3 for rubber) as weights, is

$$\frac{4\times 200\% + 3\times 50\%}{4+3} = 136\%$$

while the index number for 1913 on 1918 as base, using the values of 1918 (2 for bacon and 6 for rubber) as weights, is

$$\frac{2\times 50\% + 6\times 200\%}{2+6} = 162\%.$$

These weighted arithmetic index numbers are even more absurd than the previously calculated simple arithmetic index number. According to the simple, each year was 25 per cent above the other; but according to the weighted index number just calculated, 1918 is 36 per cent above 1913, and 1913 is 62 per cent above 1918!

Here are two doses of upward bias, one dose being in the nature of the arithmetic average and the other in the way it is weighted. Yet Palgrave proposed just such an index number, not suspecting the double bias involved.

Summarizing: (1) As to bias, it can be shown that the arithmetic average has an upward bias, *i. e.*, has in the very nature of the arithmetic process a natural tendency to give results too large, that the harmonic has a downward bias, that the geometric, median, and mode have no inherent bias in either direction. (2) As to the system of weighting, it can be shown that a system employing the prices of the base year has a downward bias, and one employing the prices of the given year has an upward bias. (3) Consequently, the only arithmetic index number which is free from the faults mentioned is one with weights in which the prices of the base year are used, such as the index number of the United States Bureau of Labor Statistics; for in such an index number the natural upward bias of the arithmetic process is offset by the downward bias in the method of weighting. (4) Similarly, the only harmonic average free from upward or downward bias is that in which the weights contain the prices of the given year. (5) The geometric, median, and mode, having no natural bias, should be doubly weighted so that the prices of both years enter on even terms.

An index number such as that of Professor Day of Harvard, a geometric with weights dependent on prices at or near the base year, will have a downward bias.

What has just been said relates to conformity to test II. There are likewise many formulae which will conform to test I. But only a few formulae conform to both test I and test II. The simplest of these and the "best" by other tests is

$$\sqrt{\frac{p_1q_1+\cdot\cdot\cdot}{p_0q_1+\cdot\cdot\cdot}\times\frac{p_1q_0+\cdot\cdot\cdot}{p_0q_0+\cdot\cdot\cdot}}.$$

It is a pleasure to learn that Mr. Walsh, approaching the subject from an entirely different point of view, has recently reached the same conclusion. Mr. Walsh's monumental and memorable book, *General Exchange Value,* showed him many years ago to be a master in this field.

While index numbers by different formulae differ materially, index numbers which conform to either one of the two great tests agree remarkably well. This is especially true of the few which conform to *both* tests.

We conclude that index numbers are far more exact than has been realized. Most of the differences are due not to the formula but to the number of commodities, or other conditions mentioned at the beginning, and differences due to differences in formulae almost disappear if we get rid of even the crudest bias.

Properly used index numbers are a precise tool, precise far beyond our needs, precise within much less than 1 per cent.

DISCUSSION

By Wesley C. Mitchell

The index number which Professor Fisher proposes seems to me excellent. Indeed, it is "the best index number" known to me for the particular purpose he has in view. Further, that purpose is an important one, covering as it does most of the uses to which what I call "general-purpose" index numbers are commonly put. But I cannot admit that even perfect adaptation of an index number to any use however important entitles it to be called "the best index number" at large.

This issue is much more than a verbal quibble. So far, most makers of index numbers of prices at wholesale have been designing "general-purpose" series. But the time has come when we are beginning to make a wide variety of index numbers especially adapted to particular uses. And we must go further in that direction. In doing such work the compiler should first define as accurately as may be the use which his new series is to serve, and from this use he should deduce the form of index number which is "the best" for him. This criterion of use should determine the number of commodities to be included, the basis on which commodities are selected, the scheme of weighting, and the type of average. What is best in all these respects for one use may be bad for another use. There cannot conceivably be an index number that is "the best" for all uses.

In fine, I think Professor Fisher has tarnished somewhat his excellent contribution by using incautious language implying universal merits in his formula. His very eminence in this progressive field of work makes that slip important. The path of future progress lies in differentiation. Yet if we took Professor Fisher at his word, we should never produce anything but one admirable kind of "general-purpose" series.

DISCUSSION

By C. M. Walsh

In the first place I wish to make an acknowledgment of appreciation for the flattering remarks with which Professor Fisher has referred to my book. In return I must express my wonder at the stupendous labor he has performed in applying so many complex systems of index numbers to the multitudinous data of the War Industries Board. It has been purely a labor of love, and it is truly admirable. But I could wish he had curtailed it in one direction, and had extended it in another. He might, indeed, have nearly halved his labor without loss. He has shown us that there are four elemental forms of weighting—q_0p_0, q_0p_1, q_1p_0, q_1p_1—two of which are mixtures of the quantities of one period with the prices of another period. These are extremely artificial, and what has happened might have been anticipated—that nothing has been gained by experimenting with them. The other two, which use in their natural connection the quantities and prices of the same period—the one, those of the base period; the other, those of the subsequent period—are the only important forms of weighting; and their employment together constitutes what I have called double weighting. Now, Professor Fisher has well shown that these latter two different weights taken singly—in the case at least of the aggregate system—have opposite defects, the one giving a bias above the truth, and the other a bias below it. This at once suggests taking a mean between them. But the mean between them can be drawn in either of two ways. The one is to carry out each aggregate system by itself, and then to draw a mean between their results. This method is now exclusively used by Professor Fisher. The other is to draw a mean between the two sets of quantities (those of every commodity at the two periods), and then to use the mean quantities in a single aggregate system. This method I almost exclusively used in my book. We both have committed opposite mistakes. It may be—and I am now of this opinion—that the first is the better method. But it needs to be proved that it is. Had Professor Fisher included the other method in his investigations, he might have thrown light on this question.

Consider these two formulae of the aggregate system:

$$(1)\quad \frac{\Sigma q_0p_1}{\Sigma q_0p_0}, \qquad\qquad (2)\quad \frac{\Sigma q_1p_1}{\Sigma q_1p_0}.$$

The first was advocated by Laspeyres in 1871. The second was adopted by Paasche in 1874. Nothing can be offered in proof of the superiority of the one over the other. They are both wrong, straddling the truth on opposite sides, as clearly appeared in some examples I used in my book, and as has now been demonstrated by Professor Fisher. In his *Elements of Statistics*, published in 1901, Dr. Bowley used the arithmetic mean between them, in this form $\frac{1}{2}\left(\frac{\Sigma q_0p_1}{\Sigma q_0p_0}+\frac{\Sigma q_1p_1}{\Sigma q_1p_0}\right)$; but he said merely that this "may be" regarded as a "first approximation," whatever that may mean. Previously, in 1887, the British Association Committee on Index Numbers had advised using the arithmetic mean between the quantities of the two periods, in this form $\frac{\Sigma\frac{1}{2}(q_0+q_1)p_1}{\Sigma\frac{1}{2}(q_0+q_1)p_0}$ (in which, of course, the two $\frac{1}{2}$'s may be eliminated). But they damned their own recommendation by declaring that, after all, weighting is of little consequence. Hence no attention has been paid to either of those index numbers, although they are much better than others that are in use. It is as important to give a good argument as it is to suggest a good thing. Indeed, the good argument is of first importance, for without it the goodness of the thing will not be perceived. Professor Fisher now holds that the geometric mean should be employed in place of the arithmetic as used by Bowley. The superiority of the geometric mean for this purpose I pointed out in my book; and I am glad that Professor Fisher has come to recognize it. I used it in place of the arithmetic as used by the British Association Committee, in this form $\frac{\Sigma\sqrt{q_0q_1}\cdot p_1}{\Sigma\sqrt{q_0q_1}\cdot p_0}$. This was one of my three best index numbers, which Professor Fisher used among his calculations, and the results of which he threw on the screen. The index number which Professor Fisher now advocates is this: $\sqrt{\frac{\Sigma q_0p_1}{\Sigma q_0p_0}\times\frac{\Sigma q_0p_1}{\Sigma q_1p_0}}$. I had referred to this only in a footnote, where, indeed, it stood the test to which I was subjecting various index numbers better than did my three. Recently I have gone over my work, and last year I wrote a pamphlet on the subject, which is not yet published, but which will probably be out within a month. In it I have taken up this very index number and added it to my other three as a fourth theoretically good one, and perhaps *the* best. But this index number was first formulated by Professor Fisher, and has been first published by him. Therefore, it should be known as Fisher's index number.

Now, how do we know that this is a theoretically good system, and perhaps the best one, or the "ideal" one, as Professor Fisher calls it? Here Professor Fisher's method and mine are very different. But I can now speak only of the tests to which it and others are subjected. In the abstract sent to us Professor Fisher used three tests. I intended to criticize one of them as not a test at all, because a test is a trial of the index number on given examples, whereas this is only a requirement. It is the demand for double weighting which I made in my book, and which Professor Fisher now repeats. In his address as delivered he makes this demand, but does not call it a test. He now has only two tests. The one is a special form of Westergaard's test. Westergaard's test is that a result obtained at a distant period by going over all the intervening periods, comparing each with its predecessor, and piecing the results together in one sequence, should agree with the result obtained by directly comparing the last with the first. But if the results disagree, Westergaard had no way of knowing which is the better one, much less which is the right one. I therefore altered his test by adding as the last period one exactly like the first, both in quantities and in prices. Then we *know* that the price-level and the exchange-value of money are the same as at the first period, and this sameness, which will always be indicated by the direct comparison, ought to be indicated also by the index number employed in comparisons among all the intervening periods, in a string or chain spanning the interval. It happens that even bad systems, which fall down before other simpler tests, will yield the right result at the end of such a chain, while they yield very differing results for the intervening periods. This test, like all other tests, in fact, is only a negative test. It cannot prove an index number, but it can disprove an index number.

It happens also that our very best systems, which meet most of the other tests and agree most closely with one another, only come near to giving the known result at the end of such a chain; but evidently the one that comes nearest, always or nearly always, is the least erroneous. Herein consists the value of this test. It is like the test to which surveyors submit their measurements when they have gone round a field and, coming back to their starting point, require that it should be accurately indicated. It may, therefore, be called the circular test. But in its use an important distinction must be observed. For its full efficacy this test must be applied to at least four periods, at least two intervening periods being different; for then we have at least two transitions that are different, and we come back to our starting point over a different track from that over which we went out; whereas, if it is applied to only three periods, with only two transitions, these transitions are exactly alike except for the mere fact of being reversed. It is true that some index numbers will not stand the test even confined to three periods; but there are others that will stand it so confined, but will fail when it is extended to more than three periods; wherefore this is a more accurate use of the test. This peculiarity attaches to other tests as well, and it was recognized by Professor Fisher when he wrote his book; for in his book he gave a half-mark to the index numbers that satisfy his tests only over three periods and a full mark only to those which satisfy them over more than three periods. Now here he has used this additional circular test—Westergaard's test as altered by me; and he has used it the first time it has ever been used since I made the alteration twenty years ago. But he has applied it to only three periods. You may be surprised at this assertion, as you can recall no reference or allusion made by Professor Fisher to three periods. But in going from a first period to a second, and then back to the first, and demanding agreement, Professor Fisher has done the same as going on from the second to a third period exactly like the first. But why has he not extended this test to more than three periods? The "ideal" system which he recommends fulfils this test confined to three periods, but does not fulfil it extended to more than three periods. I should be the last person to think that this was a reason for ignoring the full test. Why he has made the confinement, I do not understand.

As for the last test, which Professor Fisher has numbered the first, it is an entirely new one, original, and highly ingenious. I refer to the requirement that when an index number, applied first to the prices, is then turned about and by interchanging the price and quantity symbols is applied to the quantities, the two results multiplied together should yield the total value variation indicated by $\frac{\Sigma q_1 p_1}{\Sigma q_0 p_0}$. This test seems to have some merits, and perhaps might be employed to measure the relative accuracy of theoretically good index numbers. But I have not time to inquire into its merits. Professor Fisher now seems to think it a very important test. In his abstract he seemed to use it almost as the crucial test. He there wrote that as far as he knew the "ideal" index number which he recommends is the only one that fulfils this test. That sounded like an argument for this index number; and I wrote a criticism demolishing it. But yesterday Professor Fisher told me he was aware that there are other index numbers that fulfil this test. What I wrote, therefore, can no longer serve as a criticism. Still, Professor Fisher may not be aware of the great number of index numbers that fulfil this test—a fact which considerably diminishes its importance; and therefore I will read what I wrote, which presents him with at least twenty such index numbers. Not that I intend to describe all these index numbers to you. I will show you only the method of obtaining them.

The "ideal" index number, now recommended at least for its not failing to meet this new test, was formulated, as I have said, in Professor Fisher's book, and it appears in his list with the double number 15 and 16. It is doubly numbered because Professor Fisher points out that it has "the distinction of being identical with its own antithesis." If Professor Fisher will examine more closely into the matter, I believe he will find that for an index number to be identical with its own antithesis is the same as for it to fulfil this new test. This distinction did not appeal to him then as it does now. But, unless I misunderstand his correlation of price and quantity indexes, this distinction is only apparent, owing to our not having all the formulae of index numbers that we might have. I take it that most of the persons present know that Professor Fisher's list of index numbers in *The Purchasing Power of Money* contains forty-four, arranged in twenty-two pairs of antithetical formulae. The import of this arrangement I have never been able to fathom, especially since, as I have privately pointed out to Professor Fisher, some of the antithetic averages—some of the ones with even numbers—are not averages at all; and his proof that they must be rests on a wrong definition of average. Yet it is interesting to learn that some of the old familiar formulae admit of being thus opposed to each other. Now, the system in question, constituting a pair by itself, numbered 15 and 16, is the geometric mean between the two systems numbered 11 and 12, which together form one pair. It is the only formula in the list that thus draws the geometric mean between the two members of any pair; and this, I think, will turn out to be the reason why it has the distinction referred to. We are not restricted to drawing the geometric mean between index numbers 11 and 12: we can draw it between the members of any other pair, and set the resultant formula up as an index number. I note that the formulae numbered 26 and 28 each contains a misprint, which must be corrected before the right result can be obtained. I throw out the last pair, Nos. 43 and 44, because these are really not averages at all. I also reject the pair consisting of Nos. 9 and 10, because these contain the median, which I for one do not recognize as a mean. The pairs Nos. 11 and 12 and Nos. 15 and 16 having already been accounted for, there remain eighteen pairs. Now, if Professor Fisher will draw the geometric mean between the index numbers in all these eighteen pairs, I believe he will find that in every case the resultant formula will be identical with its own antithesis and will fulfil the new test. Indeed, I believe it to be demonstrable that always the geometric mean between antithetical index numbers must have these properties. And even this is not all; for if he will go on and draw the geometric mean between the formulae obtained from the second and third pairs, and again between those obtained from the thirteenth and seventeenth, he will, I believe, obtain two more index numbers possessing the same properties. We thus have a method for obtaining all the index numbers we please that will be their own antitheses and will fulfil the new test. We merely have to take any index number, find its antithesis in the way prescribed by Professor Fisher, and then draw the geometric mean between the two.

However, I agree with Professor Fisher in considering the index number he calls the "ideal" one the best one. And now, in closing, I will make an appeal for harmony; and I will make an appeal to Professor Fisher against himself. For if I have rightly grasped his conclusion, which was somewhat hurriedly read, he has ended, in spite of his recommendation of this very workable "ideal" index number, by telling us that for practical purposes either Laspeyres' or Paasche's index number is good enough, and that, therefore, as Laspeyres' index number, which uses only the quantities of the base year once for all, is the easier, it should be employed. In his book he recommended Paasche's index number, now he recommends Laspeyres'—its counterpart! If this is the result of all his labors, I regard it as very regrettable indeed. It is true that the figures yielded by these two index numbers applied to the data supplied by the War Industries Board show very slight divergencies from each other and from those yielded by the index numbers which draw a mean between them. But we should note that his investigation has continued over only four years, whereas he recommends these systems for an indefinite term of years. Yet it is a peculiarity of these two index numbers, as of several other bad ones, that their errors accumulate, so that in a long sequence they may become quite appreciable. But in any case, why employ an inferior index number when we possess a better? Mere convenience is not a good reason, and after this display of his patience and perseverance, Professor Fisher is the last one from whom we should expect a compromise with sloth. Perhaps the worst feature in the matter is that until all adopt the best method there never will be agreement; for if you once admit a compromise for mere convenience, there will be different compromises, and the confusion which now reigns in our subject, which is a disgrace to statistical science, will continue. You, gentlemen of the American Statistical Association, have a duty to perform with regard to this subject. Many of you are engaged in statistical work. Many of you advise others who are or will be so engaged. Adopt and recommend the best. Now, in researches into the past the data for a yearly comparison of quantities may not be forthcoming. Then, and then only, you may compromise because you are compelled to do so by the circumstances in the case. You can do only the best the circumstances allow. What index number should you then use? It should be this: $\frac{\Sigma q p_1}{\Sigma q p_0}$. This is the method used by Lowe within a year or two of one hundred years ago. In my book I called it Scrope's index number; but it should be called Lowe's. Note that in it are used quantities neither of a base year nor of a subsequent year. The quantities used should be rough estimates of what the quantities were throughout the period or epoch. For instance, if you are trying to get the course of the price-level since 1800, you might begin with rough estimates of the quantities for the period 1800–1815—a war period. After that, another set of estimates of the quantities should be used, which might last for ten years. Ten-year terms might be used down to 1875, after which five-year changes might be introduced. These should be still further shortened as you come nearer to the present. For recent years—and especially for the continued use of index numbers into the future—the quantities of every year should be used, and a mean should somehow be drawn between those of every two years. If the geometric mean is antipathetic to you, use the arithmetic, in Bowley's system. The difference between it and the geometric will be but trifling. But, after all, the geometric mean, being used only once in each yearly computation, is by no means beyond the amount of industry we have a right to expect from those who labor with figures. I have no quarrel with Professor Mitchell because, in editing the immense work on the *History of Prices During the War*, he attempted to use Paasche's index number and succeeded in using it only for the first three years, falling into the use of Laspeyres' for the last year, all on the quantities of an intermediate year. He was in a great hurry, and had a right to choose a simple system. But if his work is to become a permanent governmental function—if perchance it should ever be made the guiding principle for Professor Fisher's own scheme of stabilizing the dollar—then we want the very best possible system. Remember then: for the past, use Lowe's index number, and for the present and the future, use Fisher's.

DISCUSSION

By Warren M. Persons

Professor Fisher's analysis of index numbers enables us to use them with greater confidence than we formerly had in the reality of the results. He has shown that they are instruments of precision.

You may have noticed that Professor Fisher has discussed the method of averaging and of weighting index numbers of prices and production without referring explicitly to the *purpose* for which those index numbers were constructed. It seems to me that the methods of averaging and of weighting, as well as the selection of the basic data, all depend upon the purpose to which the index number is to be applied. Moreover, it is evident that Professor Fisher had a specific purpose in mind. His "ideal" index number is an index number that fits into the equation of exchange. He holds that the product of a price index, P, for any year and the corresponding quantity index, Q, must equal the relative aggregate value, V, of that year with respect to the base period. I agree that this is a legitimate criterion for indices to be used in the equation of exchange, but I am by no means sure that the criterion is one to be applied universally.

As a result of the application of his criteria for a good index number, Professor Fisher recommends as "ideal" the geometric mean between two ratios of weighted aggregates. The weights depend upon a combination of the prices and production in the given year with those in the base year. The speaker, you will notice, referred merely to *two* years in his discussion, although his charts present a comparison of the indices for several years. An index number is not computed merely to compare the index number of one given year with that for the base year but to compare the indices for a series of years with each other. Variable weighting, which Professor Fisher recommends, has the defect that we do not know whether changes in the indices result from changes in prices or production. Also the limitations to dual comparisons imposed by Professor Fisher in his discussion require a new set of weights for every pair of years compared—an endless computing job.

A problem upon which I have been working recently illustrates, first, the necessity, sometimes at least, of securing indices that are comparable each with the other and, second, the confusion that may result from the use of variable weights. I desire to find the correlation between the prices and the volume of production of twelve crops combined. To weight prices by varying production and production by varying prices and then correlate the results is to introduce an unknown element of spurious correlation. I believe that there are better ways of solving my problem than by the use of variable weights—if, indeed, the problem is solvable with variable weights.

Professor Fisher has stated that the arithmetic mean is "biased" upward and the harmonic mean is "biased" downward, without making clear his criterion of bias. The simple arithmetic mean is always larger than the geometric mean, which in turn is larger than the harmonic mean. The *weighted* means, however, are not always arranged in this order. In fact, as Professor A. A. Young has pointed out to me, the arithmetic mean of a number of items is identical with the harmonic mean of those items obtained by using correlative weights. Thus, if $p'_1, p'_2, \cdots\cdots\cdots p'_n$ represent the prices of n commodities in any year, and if $q_1, q_2, \cdots\cdots\cdots q_n$ represent the quantities of those commodities produced (or exchanged) in the base year, then the

$$\text{weighted arithmetic mean} = \frac{p'_1q_1+p'_2q_2+\cdots\cdots+p'_nq_n}{q_1+q_2+\cdots\cdots q_n},$$

and the

$$\text{weighted harmonic mean} = \frac{p'_1q_1+p'_2q_2+\cdots\cdots+p'_nq_n}{\frac{1}{p'_1}p'_1q_1+\frac{1}{p'_2}p'_2q_2+\cdots\cdots+\frac{1}{p'_n}p'_nq_n}$$

$$=\frac{p'_1q_1+p'_2q_2+\cdots\cdots+p'_nq_n}{q_1+q_2+\cdots\cdots q_n}.$$

The weighted arithmetic and harmonic means, with properly chosen weights, therefore, are identical and neither can be called "biased" with respect to the other. When Professor Fisher uses the word "bias," it is not clear to me "with respect to what" the average is biased.

REJOINDER BY IRVING FISHER

First let me thank my critics for their kind words and express my gratification that they agree with me so far as they do. The disagreements which have been expressed are, I believe, in many cases more apparent than real; and I venture to hope that any real disagreements remaining may melt away as the field is threshed over a little more thoroughly.

I am very glad to join heartily with Mr. Walsh in advocating the practical use of what I call the "ideal" formula whenever the necessary data as to quantities for both years are available. It is only when these data are not available—when merely the quantities for the base year are available, that I should propose some other formula as a makeshift.

But Professor Persons and Professor Mitchell are unwilling, at present, to agree with Mr. Walsh and myself on the "ideal" formula as the best for all purposes.

As I understand it, they express doubt rather than disbelief, and make the appeal that the particular *purpose* for which an index number is to be used must surely make a difference.

I quite agree that the purpose of an index number is a very important factor in determining what is the best index number. This is certainly true as to the elements of an index number other than the formula—the character and number of commodities, for instance. But as to the mathematical formula itself, I take a different view.

It is true in the broad field of science, that various types of mathematical averages are best suited for various widely separated purposes.

For instance, to get the average speed of an automobile we should take the *arithmetical* average of the readings of the speedometer taken at short equal intervals of time, such as every second; the harmonic or geometric mean would give false results. On the other hand, we should take the *harmonic* average if the readings of the speedometer are taken at short equal *distances*, such as at every telegraph pole; the arithmetic average as well as the geometric average would then give false results. Again, if we have a weighing balance, or scales, with unequal arms (so that the figure for the weight of an object is found to be different according as it is weighed in one pan with the counterpoise in the other, or vice versa), the true result is obtained by taking the *geometric* mean of the two conflicting results; the arithmetic or the harmonic mean would then give wrong results. Still again, in my *Appreciation and Interest* I have shown that the average rate of interest of a series of successive rates of interest (such as used, for instance, in connection with discounting the proposed German indemnity) is a certain complicated and unsymmetrical average quite different from any suitable for any other purpose, so far as I know.

As to an index number, I would hold that an index number is itself a purpose. It is a purpose sufficiently different from the purposes in the other realms just cited, and sufficiently homogeneous within its own realm, to require certain definite general criteria of its own, whatever the sub-purpose within the domain of index numbers may be.

One could agree to the statement that one system of bookkeeping is good for one kind of business and another for another, without being thereby committed to the proposition that in some businesses one mathematical process should be used and in another, another—that in some the assets should be added together and in others, multiplied. Or, again, one could agree to the statement that one kind of scales is good for one kind of business, and another for another, without being thereby committed to the proposition that in correcting the two readings obtained by weighing in the two pans, the geometric mean is appropriate when we are weighing tea, but some other average must be used for sugar.

I should like to call attention to the fact that neither Professor Mitchell nor Professor Persons has pointed out a single specific case in which the sub-purpose would require that either of the two tests which I have indicated as the supreme tests should be disregarded.

Professor Persons offers, it is true, what would seem at first glance to be a crucial test of my formula for one purpose. He wishes to compute the correlation between an index number of prices and an index number of quantities, for twelve crops; and alleges that my proposed "ideal" formula could not properly be used for this particular purpose. He thinks the correlation would be spoiled by the fact that the index number of prices involves quantities and the index number of quantities involves prices, thus mixing at the outset the two variables whose correlations he is seeking.

A little consideration will, I think, convince Professor Persons that the alleged fault in the formula is imaginary. Suppose that each one of his twelve commodities is such that its price varies inversely with its quantity or crop so that there exists a 100 per cent inverse correlation between the price of the commodity and the quantity—a perfect correlation. Were Professor Persons' misgivings well-founded, we ought to find that the index number of the twelve prices, weighted by the quantities according to the "ideal" formula, would fail to show a 100 per cent inverse correlation with the corresponding index number of quantities. But the fact is that it does show the full 100 per cent required! I shall not take the space to detail the proof. Professor Persons is well able to do this for himself. The case he cites merely adds another to the list of virtues of the "ideal" index number.

I take the liberty to hereby issue a friendly challenge to Professor Persons and Professor Mitchell to demonstrate some particular purpose for which it is desirable that an index number should not work both ways in time, or should not work both ways as to the p's and q's.

These two tests stare us in the face whenever we meet a formula for a weighted index number. For every weighted index number contains symbols for both prices and quantities, and symbols for both the given year and the base year. My tests merely require that, in both cases, the pair of symbols should be treated alike.

The formula which I call the "ideal" is, it is true, not the only possible formula which will conform to both these tests. But all the formulae which do conform to these two tests will yield figures which differ by only a small fraction of 1 per cent.

I believe that we shall reach substantial agreement, from a practical point of view at least, if we can agree merely to discard formulae which fail to conform, even fairly well, to the year-reversal test. We shall thereby rule out all the weighted arithmetic and harmonic averages (except those which reduce to price aggregates) and all geometric averages which do not have symmetrical or "double" weighting. The gross errors in the actual use of index numbers come from disregarding this year-reversal test.

In this connection, I should like to point out what seems to be an error in Mr. Walsh's statement. The "double-weighting" which he stresses so much is valuable for the geometric averages, but it is not always the best weighting. If, to give a specific example, we are using an *arithmetic* average for an index number of *prices*, the best weighting will be one in which the *prices* of the base year are used. The downward bias introduced by using the prices of the base year will offset the natural upward bias inherent in the arithmetic average. A bias-free weight is as out-of-place with an arithmetic or harmonic average as a biased weight is for a geometric average.

As to Westergaard's test, on which Mr. Walsh lays so much stress and which is evidently considered important by Professor Persons (the test, that is, by which a direct comparison between the base year and any given year is required to yield the same result as an indirect comparison found by multiplying the index number of some third year in terms of the base year by the index number of the given year in terms of the third year), I have come to three conclusions: first, a *complete* fulfilment of that test by a formula for a weighted index number is impossible; second, it is not desirable; and third, the "ideal" index number comes closer to fulfilling this test than any other.

It follows that Professor Persons is demanding the impossible when he asks that an index number on a fixed base should be usable for exact comparisons between two given years. Furthermore, his demand is more nearly satisfied by my proposed "ideal" index number than by any other, and considerably more than by the weighted geometric mean mentioned favorably by him and which Professor Day has employed for his index number of quantities.

For all practical purposes, the "ideal" index number does fulfil Professor Persons' requirement, as the deviation is usually less than half of 1 per cent even under the conditions of wide dispersement of prices and quantities in the war period of 1914–18.

The only forms of index number, out of several hundred compared, which *absolutely* meet the Westergaard test (*i. e.*, are not subject to "the limitations to dual comparisons" complained of by Professor Persons) are the *simple* geometric, median, mode and price-sum! No one has claimed, or could claim, that these are superior to weighted averages.

Professor Persons speaks of the simple geometric mean as lying between the simple arithmetic and harmonic means, and then remarks that "the weighted means, however, are not always arranged in this order." This statement is erroneous if it is assumed that the *same weights* are used in the three means compared. In the instance cited by Professor Persons, where a weighted arithmetical average is identical with a weighted harmonic, the weights are different in the two cases. This instance is like that cited in my *Purchasing Power of Money* (formulae 11 and 12, see pages 395 and 397 and headings 11 and 12 of table opposite page 418). In this and other like cases the bias of the arithmetic or harmonic average is counterbalanced by the opposite bias of the weighting used.

Where quantities for the given years are not available, so that what Professor Persons calls "variable" weights cannot be used, an index number very close to the ideal and free from any gross bias can be used, namely, the above mentioned arithmetical average, the weights being the values of the base year, which is identical with the harmonic average, the weights being the products of the quantities of the base year multiplied by the prices of the given year, which is identical also with the price-aggregate index number. This is superior to the geometric average with base-value weights favored, apparently, by Professor Persons. This geometric average is inferior just because it has no bias to neutralize the downward bias of the base-value weighting (associating, as that weighting does, high prices with low weights, and low prices with high weights).

In further reference to Mr. Walsh's criticism, I would say that there is much in my full paper which was not given at the Atlantic City meeting, partly because of lack of time and partly because the calculations have not all been finished. The calculations include those for Westergaard's test and formulae in which the mixture of the base year and given year is accomplished *in the weights* and not by taking the geometric mean of the completed formulae. I had no thought of using the former method "exclusively." I think the complete paper will also show that the work of calculating all four, instead of only two, of the weighted averages was not wasted.

Mr. Walsh is right in noting a slip which I made in the first abstract sent to those who were to discuss my paper at Atlantic City. But the slip was not quite what he took it to be. There are, of course, very many index numbers which fulfil *one* of the two supreme tests. I was speaking of formulae which fulfil *both* tests. What I should have said is that there are only a few such formulae and that among them the "ideal" is distinguished by its simplicity and by the fact that the two components of which it is formed are very close together to start with, as well as by other virtues, all of which may be fairly said to make it unique.

I hope I have, by this time, made it clear "with respect to what" an index number may be called "biased." It is with respect to its own assumed standard. If Professor Persons will collect data for the varying prices and quantities in any two towns of the United States, such as Boston and New York, he will find that any among what

I have called "upward biased" index numbers will make Boston appear to have a higher price level than New York (if New York prices are assumed as the base) and yet make New York appear to have a higher price level than Boston (if Boston prices are assumed as the base); while, reversely, the downward biased index numbers will make each city lower priced than the other! Is it possible that an index number can be good for *any* purpose whatever if it is so consistently inconsistent as to make every town higher priced than every other? Such an index number stands self-condemned!

THE MEASUREMENT OF VARIATIONS IN THE NATIONAL REAL INCOME*

By Edmund E. Day

The high significance commonly attached to variations in the national real income invites an examination of the means by which such variations are to be measured. Undoubtedly, definite conclusions must await the collection of additional data, along new as well as accustomed lines. But meanwhile various problems of method may be profitably entertained and working rules of analysis provisionally devised.

Variations in the national real income are to be ascertained by two distinct methods. In the first place, measurement of the variations is possible through an analysis of pecuniary aggregates. The national *money* income may be reduced to *real* terms through the process of deflation; that is, through dividing the money income by numbers proportionate to changes in the price level. Since the prices of different lines of goods and services behave differently during periods of general price change, special index numbers for various commodity- and service-groups are necessary if the national real income is to be accurately determined by this method of deflation. It may be questioned whether special index numbers, satisfactory for this particular purpose, are now available. But there is no reason why they cannot be constructed. Once on hand, they would render possible an approximate measurement of the national real income. An early determination of the national real income by this method of deflating the national money income is much to be desired.

The second method of ascertaining variations in the national income is by the process of direct summation of the goods and services. Of course, the goods and services cannot be combined in physical terms. It is impossible to obtain an absolute total of the real income, made up, as it is, of flour and meat, clothing and coal, automobiles and movies, and a thousand and one other diverse objects of desire. The absolute national real income is to be expressed only as a complete list of things consumed; it cannot be stated in a single figure. But *relative variations* in the national real income may be ascertained by combining relatives indicative of the volume of consumption of the different goods and services that constitute the real income. Moreover, such variations in the real income may be expressed in a single index number. Some indication of the steps involved in this method of direct summation is provided by the analysis which follows.

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* Read at the Eighty-second Annual Meeting of the American Statistical Association, Atlantic City, New Jersey, December, 1920.

Something should be said in the first place regarding the general nature of the national real income. Real income is unmistakably psychological in character. It consists of satisfactions derived from the utilization of goods and services. But what goods and services? The distinctions between free and economic goods, public and private goods, durative and consumptive goods, producers' and consumers' goods, all contribute to an answer. In general, the national real income during a given period consists of the satisfactions derived from the use during that period of consumptive and durative consumers' goods and services, whether publicly or privately distributed.

Obviously, this concept can be only roughly approximated in any statistical measurements at this time. In the first place, measurement of satisfactions is clearly impracticable. Analysis must content itself with measurement of the physical sources, or externals, of such satisfactions—with the concrete goods and services. In the second place, it is impossible to calculate the annual increment from durable goods. The accumulated stock of such goods may be ascertained; or the annual increment of new durable goods may be measured. But the general rate of utilization lies beyond statistical reach. Finally, most services are not now so recorded as to permit of statistical tabulation. True, data may be had on such services as are provided by the railway and telephone systems. But the personal services rendered by lawyers, physicians, teachers, artists, actors, and household servants are indicated only in the numbers occupied in the several branches of professional and domestic service. No available records show variations in service-income due to the varying activity of those engaged in the service-occupations. It is obvious, then, that the national real economic income as statistically measurable is considerably different from the same income as theoretically defined. Nevertheless, in view of the surpassing importance of the subject, an attempt at statistical measurement seems desirable.

So far as the national real income is embodied in goods, the most important single barometer of changes in the size of the income is the physical volume of output in manufacture. This follows from the fact that the great bulk of modern articles of consumption pass at one stage or another through factory processes. Even our foodstuffs—our flour, meat, sugar, coffee—emerge in finished form from industrial plants. Only a few commodities—fresh vegetables and fruits, milk, household coal—are not regarded as in any way manufactured. The production of all others—the bulk of our food, our clothing, our shelter—involves manufacture. The physical volume of factory output bears a definite relation to the national real income. Examination of an index of the physical volume of manufacture promises to contribute to a knowledge of variations in the national real income.

Such an index has been constructed in the course of an analysis of the physical volume of production for the period 1899 to 1919.* Separate indices have been developed for agriculture, mining, and manufacture. The index for manufacture is based partly upon material drawn from the United States censuses of manufactures for 1899, 1904, 1909, and 1914, and partly upon thirty-five series of annual data, available in practically all cases for the full period 1899–1919. The index takes the form of a weighted geometric mean of relatives obtained by reducing each item of every original series to a percentage of the 1909 item of the series. The index is obtained by a process of integration. Indices for individual industries are secured from series representing single commodity lines. Indices for groups of industries are developed by combining single-industry indices. Finally, the index for all manufacture emerges when the group indices are consolidated. Throughout the computations, the weights employed are proportionate to the values added by manufacture as shown in the census of manufactures for the base-year 1909. By means of corrections introduced at two points in the computation, the index based upon annual data is made to conform exactly for census years to the index based upon census data. The more abundant material of census years is thus made into a series of solid abutments upon which the index based upon annual data is suspended. The annual data serve to determine the year-to-year fluctuations of the index; the census data, the general level upon which the index moves.† The index, thus developed (shifted to the base 1899 = 100), is given in full in Table I, and shown graphically in Chart A.

The significance of the index for manufacture is best understood by comparing it with the corresponding indices for agriculture, mining, and population—all shown in both table and chart. The contrasts are striking. In the general course of the physical volume of production, manufacture lies between agriculture upon the one hand and mining upon the other. Agricultural production from 1899 to 1919 increased at a rate almost exactly paralleling the growth of population. The exploitation of our mineral resources, upon the other hand, proceeded at a pace greatly in excess of the rate of increase of population.

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* *The Review of Economic Statistics*, September, October, November, December, 1920, January, 1921.

† For complete details regarding the construction of the index of physical production for manufacture, see *The Review of Economic Statistics*, November 1920, pp. 309–337.

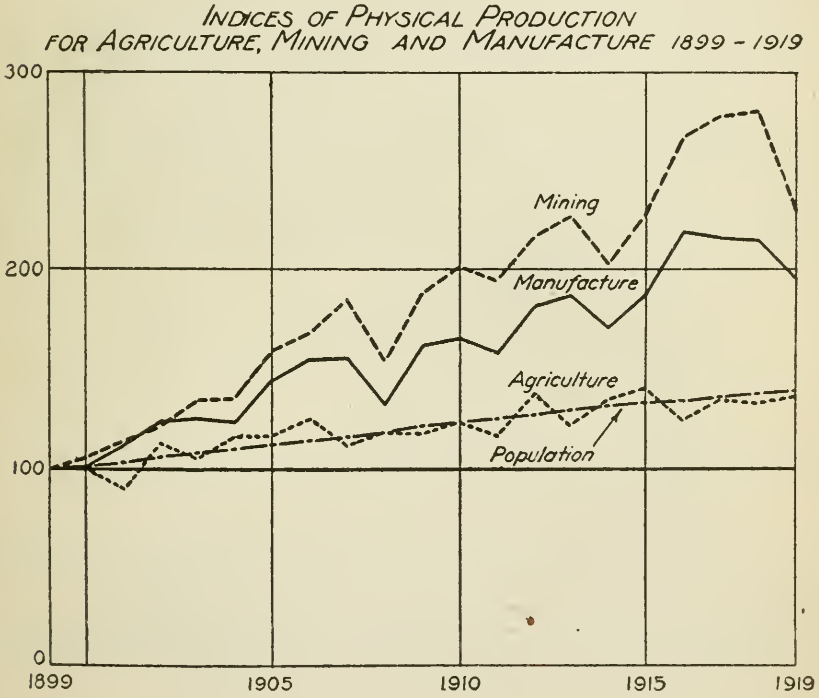
TABLE I

INDEX OF PHYSICAL PRODUCTION FOR MANUFACTURE, COMPARED WITH CORRESPONDING INDICES FOR MINING, AGRICULTURE, AND POPULATION, 1899–1919

(Items for 1899 = 100)

Year	Index for manufacture	Index for mining	Index for agriculture	Index for population
1899	100.0	100.0	100.0	100.0
1900	101.0	105.7	100.6	101.8
1901	112.4	114.6	89.3	103.8
1902	123.5	122.7	113.7	106.0
1903	125.5	135.0	105.0	108.1
1904	123.2	136.3	116.0	110.3
1905	144.4	161.6	117.5	112.4
1906	155.0	169.9	125.0	114.5
1907	156.3	185.9	112.4	116.7
1908	132.7	154.2	118.8	118.9
1909	163.4	189.4	118.1	121.0
1910	166.0	201.6	123.2	123.1
1911	158.3	194.4	117.0	125.3
1912	181.4	216.7	138.1	127.4
1913	187.1	227.2	122.1	129.6
1914	171.4	202.6	135.0	131.6
1915	187.2	227.6	141.0	133.2
1916	218.6	267.0	124.9	134.8
1917	215.2	277.2	135.0	136.5
1918	214.0	279.6	133.2	138.1
1919	195.3	228.4	137.6	139.7

CHART A



Manufacture, depending for its raw materials partly upon agriculture, partly upon mining, naturally assumes an intermediate position. Its rate of increase has been much more rapid than that of the population and considerably greater than that of agricultural production, but not nearly so great as that of mineral output. In the year-to-year fluctuations, also, distinct differences appear among agriculture, mining, and manufacture. The course of physical production in manufacture is markedly cyclical. The same is true in mining. As might be expected, mining appears to be little more than the handmaiden of manufacture. Agriculture, on the other hand, exhibits fluctuations from year to year which appear to be almost, if not entirely, independent of the business cycle. In general, the differences between the indices are highly significant, and suggestive of fundamental facts relating to variations in the national real income.

But if changes in the national real income are to be clearly recognized, a more detailed analysis must be made. Although the physical volume of production in manufacture has a bearing upon the measurement of variations in the national real income, the bearing is not a clear and direct one owing principally to the fact that the output of manufacture consists of producers' as well as consumers' goods. Stronger light will be thrown upon variations in the national real income if the general index for manufacture is broken into the ten group indices upon which it is based. These ten group indices serve to register fluctuations in the physical volume of production in certain important groups of manufacturing industries recognized in the census classification of manufactures. The ten groups for which sufficient data have been obtained to warrant the construction of indices are those engaged in the manufacture of the following products:*

1. Food and kindred products (1)
2. Textiles and their products (2)
3. Iron and steel and their products (3)
4. Lumber and its remanufactures (4)
5. Liquors and beverages (7)
6. Chemicals and allied products (8)
7. Stone, clay, and glass products (9)
8. Metals and metal products other than iron and steel (10)
9. Tobacco manufactures (11)
10. Vehicles for land transportation (12)

The indices for these ten groups, reduced to the base of 1899 = 100, are given in Table II and presented graphically in Chart B.†

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* The figures in parentheses refer to the numbering of the groups in the full census classification. The census groups for which annual data are not available are: (5) Leather and its finished products; (6) Paper and printing; (13) Railroad repair shops; (14) Miscellaneous industries.

† The indices for the lumber and vehicle groups are omitted from the Chart.

TABLE II

INDICES OF THE GROWTH OF POPULATION AND THE PHYSICAL VOLUME OF PRODUCTION OF TEN GROUPS OF MANUFACTURED PRODUCTS, 1899–1919

(Items for 1899=100)

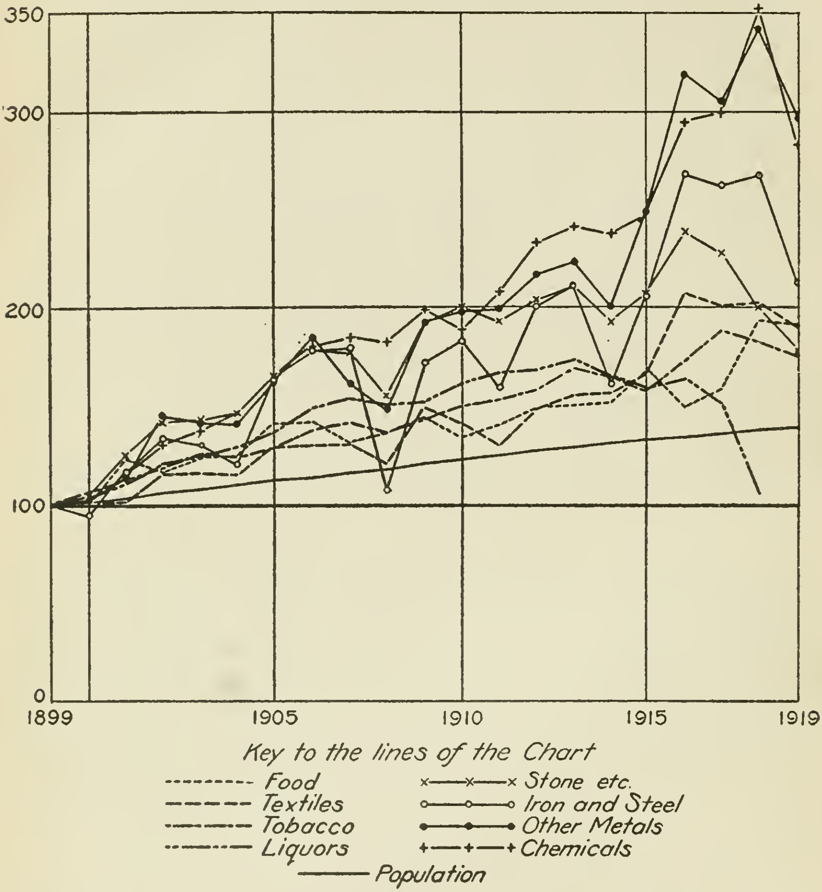
Year	Population	Lumber	Food	Textiles	Tobacco	Liquors	Stone, clay, and glass	Iron and steel	Chemicals and allied products	Metal products other than iron and steel	Vehicles
1899..	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1900..	101.8	98.1	100.7	100.6	106.5	105.7	105.4	95.5	102.6	102.3	117.4
1901..	103.8	96.2	123.1	101.5	112.0	112.9	125.2	117.5	115.5	113.1	147.2
1902..	106.0	94.3	117.3	116.0	118.1	120.9	142.0	133.3	130.2	145.8	183.3
1903..	108.1	92.4	124.5	116.1	126.0	125.6	143.1	130.2	138.6	142.4	210.3
1904..	110.3	90.7	125.0	115.8	124.8	129.4	146.8	120.4	146.6	141.4	186.5
1905..	112.4	97.4	141.3	129.2	128.4	137.6	165.3	164.2	165.5	163.9	284.4
1906..	114.5	109.1	142.1	130.4	138.2	149.4	178.4	178.7	180.4	184.7	356.7
1907..	116.7	115.8	132.2	131.9	141.8	153.6	177.4	179.7	184.4	161.8	430.5
1908..	118.9	112.4	136.2	121.5	136.3	149.3	155.3	107.7	182.0	148.5	286.8
1909..	121.0	126.2	144.3	149.2	143.6	151.5	192.6	171.8	199.2	192.6	354.5
1910..	123.1	123.2	134.3	141.2	150.7	161.6	200.7	183.2	189.6	198.4	522.2
1911..	125.3	116.1	140.4	130.3	153.7	165.6	193.2	159.6	208.3	199.0	377.6
1912..	127.4	118.7	149.5	148.4	158.6	168.5	204.0	201.0	233.4	216.3	650.6
1913..	129.6	113.4	151.0	155.8	169.1	173.4	211.2	211.2	240.6	223.9	769.8
1914..	131.6	101.8	152.7	157.3	165.0	164.5	193.8	161.3	238.8	200.3	657.8
1915..	133.2	95.6	169.7	167.8	158.8	158.3	208.6	205.3	247.8	248.1	747.4
1916..	134.8	100.6	150.8	207.6	173.4	163.8	238.1	268.9	294.8	319.0	1304.6
1917..	136.5	90.5	159.5	201.4	188.8	151.2	227.5	262.7	299.0	305.0	1483.3
1918..	138.1	80.4	194.2	202.7	183.0	105.0	200.5	267.9	353.8	343.5	1019.5
1919..	139.7	85.5	191.1	190.7	176.0	....	178.8	212.7	282.2	296.1	1373.8

The outstanding feature of these lesser indices is an unmistakable grouping in the movement of the indices during the pre-war period 1899 to 1913. Examination of the indices shows that, while the index for vehicles rises to an extraordinary height, and the index for lumber remains upon an unusually low level, the other eight indices fall into two well-defined sets,—one consisting of the indices for iron and steel, stone and clay, non-ferrous metals, and chemicals; the other, of the indices for food, textiles, tobacco, and liquors. The distinction between the two sets is clear. The commodities produced in the first set consist primarily of producers' goods; those in the second set, of consumers' goods. It follows, of course, that the second set of group indices has a much more direct bearing upon the national real income than the first.

Careful examination of the various group indices for the full period 1899 to 1919 yields a number of interesting tentative conclusions. In the first place, the production of producers' goods has increased at a much more rapid rate than the production of consumers' goods. Presumably those portions of the national real income which consist of services derived from large-scale plants, such as railroads and telephone systems, share in the very rapid increase of volume which distinguishes the indices of this class. In the second place, it may be concluded

CHART B

INDICES OF PHYSICAL PRODUCTION
FOR IMPORTANT GROUPS OF MANUFACTURES. 1899 – 1919



that the rapidly increasing output of *producers'* goods, used partly to maintain, partly to enlarge, existing industrial plant and equipment, has the indirect consequence of increasing the domestic manufacture of *consumers'* goods. It is not surprising, therefore, to find the production of consumers' goods apparently increasing more rapidly than the population.* In the third place, the group indices confirm the conclusion, previously drawn, that the manufacture of goods made from mineral raw materials has increased more rapidly than the manufacture of goods made from agricultural raw materials. In the fourth place, the fluctuations of manufacturing output which mark the business cycle, though conspicuously greater in the industries producing capital goods than in those producing consumption goods, appear to be so considerable even in the latter industries as inevitably to involve year-to-year variations in the volume of goods passing to the consumer. These conclusions, general and tentative as they are, make a beginning in the analysis of changes in the national real income during the past twenty-one years.

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* This more rapid increase cannot be fully accounted for by the tendency for consumers' goods to pass in more and more complete measure through manufacturing processes and commercial exchange.

Taken as a whole, the results of the study of the physical volume of manufacture are intended to suggest a practical mode of analysis rather than definitive conclusions. For the reliable measurement of the national real income, investigation must be extended to include: (a) fluctuations in the stocks held by manufacturers, jobbers, and retailers; (b) changes in the physical volume of exports and imports; (c) variations in real income in the form of personal services. Reasonable approximations, if not full measurements, of these elements are becoming more and more feasible. With these elements included, the analysis should produce highly significant results. Direct measurement of the variations of the national real income is one of the lines to be most carefully cultivated by current statistical investigation.

A NATIONAL MONEY ACCOUNTING AS THE BASIS FOR STUDIES OF INCOME DISTRIBUTION*

By M. C. Rorty

A recent writer has revived,† in very interesting fashion, an old discussion as to whether man, as we know him, originated from solitary or from social progenitors. He argues, rather convincingly, from evidences of language and primitive customs, that the ancestors of man must have been highly socialized animals living much like the bee and the ant, and that the man-like apes represent side branches, or outlaws, from the evolutionary tree.

This discussion, aside from its purely scientific interest, has its very practical aspects. We shall have one very definite attitude toward present day political evolution if we believe that society is developing from a primitive individualism toward a highly socialized form. And we shall have quite a different viewpoint if we see in human evolution a steady progression from a primitive and excessive socialism toward a scientific individualism which shall combine a large measure of personal freedom of initiative with the advantages of collective effort, where collective effort is required. In the one case, the Marxian type of socialism represents at least a tendency toward progress; and in the other case, it represents economic infantilism, a mere atavistic recoil from economic growing pains.

These two viewpoints are, in some respects, as widely separated as the poles. Yet they have common ground in an agreement that the ultimate test of any social or political plan must lie, first, in the gross production of the tangible and intangible things (goods, services, and gratifications) that satisfy normal and proper human desires; and, secondly, in the equalities and inequalities of the distribution of such gross production among individuals and families. Opinions may differ as to the relative weights that should be assigned to tangible and intangible products. They may differ, also, as to what uniformity of distribution is equitable or socially desirable, as to how far a diminution of the present inequality might increase production, and as to the extent to which gross volume of product should, if necessary, be sacrificed for the sake of such uniformity. But they must agree as to the vital need, from year to year, and from generation to generation, of reliable and accurate measures of the production and the distribution that is taking place.

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*Read at the Eighty-second Annual Meeting of the American Statistical Association, Atlantic City, New Jersey, December, 1920.

† Ford, Henry Jones, *Natural History of the State.*

The fact that all shades of political theory have this common meeting ground has, in recent years, lent special interest to the studies of income distribution such as those of Dr. King in the United States, and of Professor Bowley in England. This interest attaches, also, to closely related investigations such as those recently made by Professor Friday. But, in spite of this general interest, too little attention has yet been paid to the necessity for the establishment, in such analyses, of a definite procedure that will permit significant comparisons to be made between the results of successive investigations. In measuring the effects of social, industrial, and political changes, it is much more important to maintain continuity and comparability in successive studies than it is to secure an ultra-refinement of accuracy in any single one of the series. With this necessity in mind, the writer is attempting to suggest the more important details of method that should be observed in studies of income and income distribution. He also presents, briefly, the reasons for centering such investigations around that semi-exact national money accounting which is becoming more and more practicable with increasing accuracy in income tax statistics and increasing publicity in respect to financial and corporate activities.

In approaching this general problem, the first necessity is obviously for a consideration of those progressive changes in the forms of national income which may affect the comparability of present and future studies.

If we go back only as far as early Colonial days in this country, we find that the bulk of the real income of the population was not in money, but in the products of farms and home industries consumed directly by the producers and their families; and today there are still many isolated and almost self-contained farms that produce comfortable livings, even if they produce very little in the way of actual money income. The use of urban home properties by their owners and the services of housewives to their families are other large items. All of these elements in the national product are real. Furthermore, each item is tending year by year to assume new forms that are measured in terms of money. Farm and urban tenantry is increasing. The self-contained farm is giving way to the farm that specializes on money crops, and even the housewife is seeking gainful employment and is buying the family meals at the delicatessen-shop.

Besides these changes, there are others of a different sort that are quite as fundamental. In an advancing civilization there is naturally less and less of our national effort devoted to the production of necessities, and more and more to the production of luxuries, to education, to governmental services and activities, and to entertainment. We are spending larger sums each year for sanitation, for police and fire protection, and for good roads. We may even continue to spend increasing sums for improved varieties of warfare. Moving picture exhibitions and great battles are, in fact, as truly a part of the national product as are bread and meat. A survey of the national product a generation ago might perhaps have shown a per capita output of fundamental necessities not very different from the present, but a comparison on this basis would be entirely misleading.

When all of these factors have been considered, it becomes evident that we must have an initial broad definition of the tangible (annual) national product, which definition must include:

a. The output of goods for individual consumption.

b. The output of items of non-productive and non-consumable, or only slowly consumable, wealth; *i. e.*, jewelry, pleasure automobiles, etc.

c. The output of productive structures and machinery, less replacements; *i. e.*, the net increment of such items.

d. The value of all private and corporate services to individuals.

e. The value of all governmental services to individuals.

f. The annual value of all direct individual use of productive property and machinery; *i. e.*, mainly the use of home property by its owners.

g. The net income (positive or negative) from international investments.

h. The net earnings (positive or negative) through international interchanges of the services of capital and persons; *i. e.*, mainly with respect to shipping and cable facilities, but including also sums paid in respect to patents, copyrights, etc.

i. Net balances (positive or negative) with respect to taxes paid by, and governmental services furnished to, colonies, protectorates, and dependencies.

Several of the items in the preceding definition require explanation in detail, and there are certain general considerations that affect the definition as a whole.

As to the general considerations, it is necessary to note, first of all, that the national product can be measured only as and where it serves individuals, *i. e.*, at the point where individual consumption occurs or final title is taken. The real products are not wheat on the farm and cloth in the factory, but bread on the table and clothes on the backs of human beings. Coal at the mine has no final or definite meaning, from the standpoint of human subsistence and comfort. Some is used for the heating of homes, but much is consumed in its own transportation to the point of use, and still more is consumed in the production of other final products and services. Also, through the operations of international trade, many of our domestic products take, in large part, new forms before they pass into the hands of our individual users.

Similarly, with regard to necessary replacements of productive structures and machinery, there is no essential economic difference between the coke that is burned in a blast furnace and the blast furnace that is worn out in the iron-making process. The labor and raw materials that enter into both appear finally in finished iron and steel products, and should not be counted a second time in summing up the national output. Replacements of non-productive wealth do not, however, fall under this ruling. This difference may be made clear through a comparison of motor-trucks and pleasure automobiles. Necessary replacements of motor-trucks are an integral part of trucking costs and are reflected finally in commodity prices; but the wearing out of a pleasure automobile is exactly comparable to the wearing out of a suit of clothes or to the consumption of a loaf of bread. Therefore, in general, the entire output of pleasure vehicles should be included in the national product, while the output of commercial vehicles can be counted only in part.

Still a further point applying to the broad definition of the national product is the necessity of valuing the whole in terms of a common money denominator. No valuation of the national product, or picture of its distribution, could have a workable meaning if it were in terms only of loaves of bread, suits of clothes, and tons of domestic fuel. Furthermore, many of the items, such as the use of residential property, and most forms of private, corporate, and governmental service, have no practical measure except in terms of money; whereas other items, such as the net balance of income on international investments, are primarily in the form of money, even if later they are converted into commodities. This necessary summing up of the national product in terms of money carries with it the necessity for an interpretation of the final result in terms of a proper price index. The nature of this index may, however, be discussed more appropriately at a later point in this paper.

All of the preceding considerations tend, in the end, only to emphasize still further the need for a comprehensive definition of the national product, such as that previously outlined. Yet it is equally obvious that such a definition does not offer a practicable primary basis for the studies that must be made. The distribution of the total product must, in any case, be determined very largely from statistics as to actual and equivalent individual money incomes. Furthermore, it is almost impossible to make a direct summation of physical products, and it is still more difficult to value them at the points where final titles are taken. Such a summation might conceivably be made if there were accurate records of all retail and other final transactions; but it is only necessary to be told that there are approximately 2,000,000 retail establishments in the United States to realize that such an approach is entirely unworkable today, and probably will continue to be very difficult in the future, even with a considerable development of sales taxes and other new sources of statistical information. And, finally, there are properly included, in the broad definition, many items that cost money and consume human effort, but are of very doubtful real value. To consider only one such item, the services of courts, jails, and policemen are units in the sum of governmental activities quite as truly as the services of the public schools, in spite of the fact that one class of service is highly productive, while the other is merely an attempt to reduce waste.

With these difficulties in the direct summation of the national product once recognized, the alternative procedure which suggests itself is to work primarily through a summation of individual money incomes and to supplement and check the results so obtained by means of other data.

It is at this point that the very helpful concept of a national money accounting first comes in. Such an accounting is, in effect, a detailed analysis of the continuing round flow of money from individual money incomes to individual expenditures, through the accounts of individual and corporate entrepreneurs and governmental agencies, and back again by sources—salaries and wages, rents, interest, dividends and profits—to individual incomes. The balances involved are necessarily those of a cash accounting, and incomes, for this reason, must be measured in terms of receipts rather than accruals. Certain entirely practicable adjustments must also be made for credit expansion and contraction, for the effects of international investments and international trade, for "invisible" trade balances, for corporate surpluses, etc. But with these factors once recognized, the procedure is such as to enable effective use to be made of practically every source of statistical information that is available. Furthermore, the method in question has the very special advantage that it enables many items of information to be cross-checked and balanced in the early stages of their use before they are combined in the final summations.

Limitations of space and time necessarily prevent a full discussion of details in the present paper. Such discussion would, in any case, come more appropriately from Professor Mitchell and his corps of assistants, who are at the present moment developing and applying some features of this method in connection with a new study of the national income.

In general, however, the procedure involves three steps: first, a summation and distribution of individual money incomes; second, a summation of individual expenditures, counting savings as expenditures by indirection, which summation may in practice be arrived at through a summation of that portion of the national product to which title is taken directly or indirectly by individuals in return for money payments; and, finally, a summation of individual money incomes by sources. The fact that all of these summations are tied together in the money accounting makes it possible, as previously noted, to apply many very effective intermediate checks. For a single example, available statistics concerning individual incomes make it possible to determine with considerable exactness the relation between total income from personal service, and total income from interest and dividends; and these figures may be very closely checked through studies of the relation between the disbursements of individual and corporate entrepreneurs with respect to interest, dividends, and profits on the one hand, and to salaries, wages, and their equivalent on the other. The particular effectiveness of this check arises from the fact that the variations, between different establishments, in the relative disbursements to capital and labor are not only very much less, but also very much more easily determined, than are the variations in the percentages of return on total invested and borrowed capital.

When the details of procedure with regard to the money accounting have been determined, the final problem is that of the adjustment and interpretation of the results.

The major adjustment that is required concerns certain forms of tangible income that do not appear as money. The largest and most important items of this kind are the use of home properties by their owners, and the consumption of food products and fuel by agricultural producers. These adjustments must be made in terms of the amounts that are paid as rents for equivalent home properties occupied by non-owners, and in terms of the prices that are paid for equivalent fuel and food by the general population; otherwise, comparability will be lost not only between various groups in the population, but also between successive studies and between nations that differ widely as to the proportions of their workers that are engaged in agricultural and industrial pursuits. The general principle in this respect is to supplement money incomes by valuations of all forms of tangible non-money income that do now involve, or may in the future involve, money expenditures on the part of any considerable proportion of the population.

A further somewhat similar adjustment that might be required concerns the tendency for the services of the housewife to the family to be replaced by hired services, while she undertakes gainful employment. This correction may, however, be avoided by making the studies in terms of individual rather than family incomes. The question of family incomes and of family standards of subsistence must, in any case, be a subject for supplemental consideration; and the primary study cannot hope to do more than to indicate, for workers and other income receivers of various grades and classes, the amounts and purchasing power of their average incomes.

The reference just made to purchasing power brings up the first question in the interpretation of results. The world's very recent experience has shown only too well the lack of permanent significance in money incomes. The obvious and necessary step is to supplement each study of the national income with a careful determination of an appropriate price index. Since we are dealing with the incomes and expenditures of individuals, this must be primarily an index of retail prices; and, furthermore, since comparisons over long periods of time will be important, it may be desirable to use two indices, one based upon the prices of the fundamental necessities, and the other based upon an average of the items entering into the normal family budget at the time when the study is made.

A further important point of interpretation is that regarding direct taxes. Since governmental services, in the main, are not only necessary but also, in many cases, distinctly productive, it would be improper to deduct income and other direct taxes from the first summation and distribution of individual incomes. Nevertheless, the fact that a large proportion of direct taxes are based on ability to pay, rather than on the value of governmental services to the individual taxpayer, makes it necessary to set up a supplemental statement of the distribution of the national dividend after deducting direct tax payments. This will leave the balances that are really available for savings and for personal expenditures on commodities, and on services other than governmental services. Supplementing this adjustment there should, however, be certain estimates, in the reverse direction, of the tangible values of governmental services to various classes of income receivers. Instruction in the public schools is one of the most important of such services, and comparisons of real incomes made internationally, or between successive periods, would be quite misleading if this item should be neglected.

Still other necessary angles of interpretation appear in the consideration of the basic sources of income. It is particularly necessary, in these controversial days, to make clear separations between returns for personal service, rents of natural resources, and returns on capital goods. The so-called "profits" of individual entrepreneurs are very frequently treated *in toto* as return on invested property, although on close analysis very large portions, if not the bulk, of such profits are found to represent only very modest returns for productive personal services rendered by the individuals involved. Some approximate separation of the entrepreneur's profits into these two elements should, therefore, be made. Similarly, it is very desirable to make at least an approximate determination of the total part of all individual incomes that is derived from the rents of land and other natural resources. This separation is not extremely difficult with regard to agricultural and residential property, but it is difficult with respect to land and other natural resources used by corporations and capitalized in their security issues.

It is not necessary to exhaust here the list of such possible interpretations and amplifications of the results of income studies. The examples given should be sufficient to indicate not only the need for such supplemental analyses, but also the practicability of establishing for them a reasonably definite and permanent procedure.

There is, however, one further special and very important point that must be mentioned—the economic meaning of additions to the surpluses of business enterprises and their position and proper treatment in studies of income and income distribution.

First of all, as to the nature of such surplus earnings, an initial subdivision may be made into the following elements:

a. Book profits based on revaluations of assets, etc.
b. Necessary, but unrecognized, insurance against contingencies and ultimate losses; *i. e.*, in the long run, a real expense of doing business.
c. Reinvestments in excess of the above, which never become the basis for dividends.
d. Reinvestments which sooner or later do become the basis for dividends.

The preceding separations tend to make clear the fact that additions to corporate surpluses cannot be treated *in toto* as returns to investors. The actual distribution of interest, profits, and dividends to individuals is the only tangible thing that can be dealt with. This tangible distribution may, of course, be affected in the future by present reinvestments, just as the present distribution is, to a considerable degree, affected by past reinvestments. Undistributed earnings may, in some cases, increase future dividend payments, although this increase will very rarely be as great as it would be if plant and business extensions had to be financed wholly out of new security issues. In other cases, they may tend to increase wages in the industries involved. But in the long run, it is probable that the principal tendency is to reduce prices of commodities and charges for corporate service This is very certainly the case in connection with public utilities operating under close regulation.

Another viewpoint regarding undistributed business surpluses is that of their bearing on the distribution of the national product. It is rather easy to show, first of all, that they have no direct effect on the round flow of money or on the relative distribution of total money income between personal service, capital, and natural resources. The ten dollar bill that goes to a shoe factory for a pair of shoes will show up again as some person's individual income with equal certainty, whether it is spent wholly for shoe materials and the wages of shoe workers, or whether it is spent in part for the erection of additions to a shoe factory, or is taken by the government as excess profits taxes and spent for the support of government bureaus or the military establishment. In general, also, the way in which the money is spent will not greatly affect the percentages that finally appear as salaries and wages, dividends, etc. The only real result that develops from the existence of undistributed business earnings is, therefore, to hold title to a certain portion of the national product in suspense. It is not proper, however, to add the value of such suspense items to the money total of the national dividend. The actual operations are more nearly comparable to what occurs when the government imposes a sales or other indirect tax which is eventually reflected in commodity prices, and invests the proceeds in permanent buildings; although, in the case of surplus earnings in freely competitive industries, the source of the investment fund is not increased prices, but the withholding from investors of what may be described, rather elaborately, as the profits of supra-marginal efficiency of management and the rents of supra-marginal competitive advantage.

This analogy between land rents and the excess of the profits of non-marginal over those of marginal competitive concerns, has lately received considerable attention, and is the basis for much support given to excess profits taxes as a permanent source of governmental revenues. It may not, therefore, be out of place to conclude this paper with the suggestion that, as between governmental agencies and a large and growing number of public utility and industrial organizations, there is at least an even chance, both now and for the future, that equally effective and more direct social use may be made of surplus earnings if they are expended by the business enterprises rather than by the government. This is particularly true where business policies are in the direction of moderate rates of distribution of earnings, and the reinvestment of all balances in extended and improved productive plants, or other expansions of business activity.

THE CONDUCT OF THE FOURTEENTH CENSUS*

By WILLIAM M. STEUART, *Assistant Director of Census*

The debate in Congress attending the enactment of the law establishing a permanent census office, the discussions in statistical organizations, and newspaper and magazine articles are conclusive that the purpose of the law was (1) to advance and perfect the publications of the decennial census; (2) to assist in the elimination of the duplication in the statistical work of the various bureaus of the federal government.

We are now principally concerned with the first of these objects. A large force, approaching 100,000 supervisors, inspectors, clerks, agents, and enumerators, is suddenly turned loose on the country to collect important data concerning the inhabitants and their industries. The force is scattered over a vast territory with more complex social and industrial conditions than exist in any other country of the world. The period of employment is short, and the rate of pay is not attractive. No compensation can be allowed for preparatory work or study of instructions. Comparatively few of the persons engaged can come into personal contact with the administrative staff. The territory to be covered by each employee must be definitely described, and he must be familiar with it and with his instructions, so as to commence work on a fixed date. It is futile to expect such a force to be organized and fully equipped unless there is a well-organized staff and ample time is allowed for preparatory work. Naturally, the best organization cannot be secured unless the head of the Bureau has had some experience in the organization of a census. Otherwise, he cannot appreciate the relative importance of the various processes, or estimate the time at which they should be finished in order to begin other processes upon which the results depend. General Francis A. Walker was superintendent of the censuses of 1870 and 1880, but since then each census has had a different director. Some of the directors had had wide administrative experience but a very limited knowledge of statistics. Others were eminent statisticians but had had little administrative experience. It may be impossible to secure a man who has had proper experience in both fields. At any rate, service through at least one census is necessary to a proper conception of the work. Unless the head of the office has a clear vision of the magnitude and ramifications of a census, it will be almost impossible for him to perfect an organization in advance of the work.

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* Read at the Eighty-second Annual Meeting of the American Statistical Association, Atlantic City, New Jersey, December, 1920.

PREPARATORY WORK

Changes in the census law that always have been, and I suppose always will be, made prior to the taking of each census affect the scope and character of the inquiries and the general conduct of the work. The office is in ignorance of these changes until all the provisions of the law are finally decided. The law for the Fourteenth Census was not approved until March 3, 1919, and the census period commenced the following July. The appropriation for the work was not available until July 1, and, technically, no work could be done until after that date. There was, of course, an implied understanding that the permanent force of the office would or could be employed on the preliminary work for the decennial census in advance of the census period; but other duties were imposed upon the Bureau in connection with war activities and intercensal investigations that made it impossible to give proper attention to the preliminary organization for the decennial census. There was thus a constant pressure to postpone this organization. The result was that when the time for the actual enumeration arrived not all the enumeration districts had been established, some of the blanks had not been printed, and some had not even been drafted. An accurate description of each enumeration district is essential to the correct enumeration of the population. Changes are constantly being made in the boundaries of the political divisions and subdivisions of each state; and the enumeration districts must be so arranged as to harmonize with these political units and to make possible the preparation of a total for the population of each. I refer to this because it is one of the most important pieces of preliminary work required for a census. Its proper performance requires an extensive correspondence with local officials throughout the country, and considerable personal field work. I believe I am safe in saying that at no census has it been properly and satisfactorily concluded before the time for the enumerators to begin work. This condition is, without doubt owing to the lack of appreciation of its importance. The lack of definite and positive understanding concerning the boundaries of the enumerators' districts caused delay and more or less confusion in the offices of the supervisors and many errors by the enumerators. There are also many other things that should be done before the actual work begins that never have been done.

CHANGES IN CENSUS LAWS

The law governing the Fourteenth Census differs in many respects from that providing for the Thirteenth Census. There are at least five changes and groups of changes that seriously affect the work: (1) The provision for a census of Guam, Samoa, and the Panama Canal Zone; (2) the appointment of supervisors by the Secretary of Commerce upon the recommendation of the Director of the Census; (3) the advance of the date of the enumeration from April 15 to January 1; (4) provision for the amplification of the irrigation inquiry and for the enumeration of drainage projects; and (5) changes in the population and agricultural inquiries.

Aside from the law, the scope of the census and the organization decided upon by the Director were dissimilar in some important respects to the corresponding features of the Thirteenth Census. The appointment of the supervisors by the Secretary was an improvement over the method employed at preceding censuses. If the law had been enacted a year earlier, a much more satisfactory organization would have been possible. The accuracy of the entire census of population and agriculture depends upon the efficiency of the supervisors. Their temporary employment is the survival of the former custom of creating a temporary organization for each census. Some time I hope the practice will be abolished, and the work done by the regular trained employees of the Bureau. Such an arrangement will not only reduce the expense, but will greatly reduce the margin of error and advance the completion of the enumeration. Two districts, Porto Rico and Hawaii, were supervised, and the work in three or four others was completed, by the regular employees. In other cases it was necessary to station one or more of the regular census force in the office of the supervisor to insure a satisfactory enumeration. The position of supervisor is so temporary that the person appointed cannot, or in the majority of cases does not, give up his other employment. The census work, therefore, is secondary, and does not receive proper attention. It is needless to give examples of indifferent work on the part of supervisors. To have this, the most important piece of census work, done by temporary employees who have had no prior experience and who know nothing of census taking, is, to say the least, very poor administration.

The change in the date of the enumeration was made at the request of the Department of Agriculture, and also because it was contended that more people would be found at their usual places of abode in January than in April. I agree that if the enumerator is able to see the farmer in January he is more likely to get correct data concerning the operations of the farm during the preceding year than he would be from an interview in the following April. But the enumeration of the population is the principal object of the census, and the experience at this census has convinced me that a more nearly perfect and a more rapid count of the people can be made in April than in January. It is true that during April and June, when the enumeration has heretofore been in progress, large numbers have been at summer resorts. But at this enumeration it was found that surprisingly large numbers were at winter resorts. Thousands who have their usual places of residence in the northern states spend the winter months in southern California, Florida, and other southern states. Some of them live in the south several months of each year, and it was difficult to determine their usual places of abode. In this respect the change complicated the work; certainly it did not simplify it.

The weather in the winter is a serious impediment to the work of the enumerators, especially in the rural districts, and it is probable that the change in the date increased the margin of error caused by defective enumeration.

THE CENSUS SCHEDULES

But few persons realize the importance of care in the wording of the census schedules. The Fourteenth Census covers population, with special schedules for the blind and deaf; agriculture, with a special schedule for animals in barns and inclosures not on farms; manufactures (including forest products), with 85 supplemental schedules; mining, with 44 supplementals; irrigation; and drainage. There are in all 138 schedules upon which data required for some branch of the census must be reported. There are hundreds of inquiries to be answered—not all by every individual, but some by all individuals. Each director, from General Walker down, has called attention to the necessity of simplifying and reducing the number of census inquiries, and has referred to the overburdening of the enumerators and the impossibility of obtaining correct replies to all the inquiries in the short time allowed for the work. Yet there is constant pressure to extend the census inquiries and to reduce the time allowed for the field work, so that the more complicated office work can be completed within the census period. The practice of relieving the enumerators of the schedules for manufactures, mining, irrigation, and drainage that has developed during recent censuses has tended to reduce their work, but at the same time the other schedules have been extended. The instructions to enumerators fill a pamphlet of more than 50 pages. It is unreasonable to expect men or women appointed for such temporary work at such low rates of compensation to take time even to read through such extended schedules and instructions. The applicants were required to prepare a formal application, to take a practical test, and attend schools of instruction; but there were more than 86,000 enumerators to be instructed, and the instructions were necessarily more or less superficial. I, personally, instructed some classes, and could not do more than touch on the most important features.

We are now making every effort to compile a reasonably accurate census and to publish the results within the time required by the law. But our population and industries are increasing rapidly, and it will be impossible at subsequent censuses to do the work as now outlined. The number of inquiries must be reduced or the time extended. Mr. Durand, director of the Thirteenth Census, in a memorandum left for assistance at subsequent censuses, states that it is of the utmost importance to the success of a census that the schedules should be simplified to the last possible degree consistent with obtaining fundamentally essential information.

It is not an easy task to omit inquiries. The law directs that certain subjects shall be covered, and pressure is constantly being made to extend the scope of these inquiries and to add new ones. The files of the office are full of correspondence and reports of committees on the subject. To illustrate: There is no very clear authority of law for making an enumeration of poultry, either on farms and ranges or not on farms and ranges. The wording of the law of 1910 was that the schedules relating to agriculture shall include "number and value of live stock on farms and ranges; number and value of domestic animals not on farms and ranges." The Department of Agriculture has construed the words "live stock" to include poultry, and as the law specified "domestic animals" not on farms to be reported, poultry was omitted in 1910 from the schedule for barns and inclosures not on farms. In the law for 1920 the words "domestic animals" were omitted and the words "live stock" substituted. To one not acquainted with the technique of census work this appeared to be a perfectly harmless change, but it was presumably made on the supposition that an inquiry in regard to poultry raised in cities would or could be added to the schedule to be applied to barns and inclosures not on farms. Such an inquiry would increase the cost of the field work by about $50,000 and add a proportional amount to the cost of the office work; in addition, it would increase the burden on the enumerators.

Important as the other inquiries may be, the reputation of the Census Bureau depends upon the speedy and correct announcement of the population. The population schedule for 1910 contained 34 columns, and for 1920, 29. The inquiries omitted were "Number of years of present marriage"; "Number born," and "Number now living," for children of each mother; "Whether out of work on April

15, 1910"; "Number of weeks out of work during year 1909"; whether the place reported was a "Farm or house"; "Whether a survivor of the Union or Confederate Army or Navy"; "Whether blind (both eyes)"; and "Whether deaf and dumb." At the present census the last two inquiries were covered by a supplemental schedule on which the enumerator recorded the name and address of each blind or deaf person. Thus there was apparently an elimination of nine inquiries from the 1910 schedule, two of which, however, were carried in different form on a supplemental schedule. On the other hand, the 1920 schedule contains four new inquiries, one of which relates to year of naturalization and the other three to mother tongue. Strictly speaking, however, the mother-tongue inquiry is not a new one, because, although the schedule for 1910 did not make any provision for it, the enumerators were instructed to report the mother tongue in the column calling for place of birth. This method was not satisfactory, and on the 1920 schedule separate columns were provided for mother tongue. Thus the actual net changes consisted in the dropping of seven inquiries and the addition of one.

The mother-tongue inquiry was technical and required great care to secure correct answers. The records of the Bureau contain the following recommendation by Director Durand concerning this inquiry:

> "Another inquiry which it is probably desirable to eliminate is that with respect to mother tongue, except for persons born in a few foreign countries where there is a great mixture of population. This inquiry, which was considered the best available guide for determining racial stock, was provided for by an amendment to the census act, passed only a very short time before the enumeration. It was recommended by the Director of the Census, partly on account of the scientific value of the information, but more because of the insistent demand of the leading representatives of the races coming from Austria-Hungary. There is no question that the information would be of much scientific value if it could be obtained with accuracy and without unduly burdening the enumerator. Save with respect to a few countries, however, the return of country of birth itself is a very close guide to the racial stock of the people, and the additional information secured by the mother-tongue inquiry is not worth the trouble and expense it causes. For instance, persons reported as born in Italy are so nearly all Italians that there is practically nothing gained by distinguishing the few who may by chance have other mother tongues. The same is true of England, Scotland, Wales, and Ireland, of the Scandinavian countries, of Spain, and, in fact, of the larger part of the countries of the world.
>
> "On the other hand, it is well known that there is a remarkable mixture of different races and mother tongues in Austria-Hungary, Germany, and Russia, and that in Canada there is a wide difference between the French-speaking and the English-speaking population. For example, to report the characteristics of persons coming from Austria-Hungary, without distinctions of race, is decidedly unsatisfactory, because of the wide difference in characteristics between the Germans, Poles, Bohemians, Magyars, and other races of that country. Both for scientific reasons and in order to meet the wishes of the people who have come to the United States from the

four countries above mentioned, it is undoubtedly desirable to retain the inquiry of mother tongue regarding them. The elimination of the inquiry with respect to persons born in other foreign countries would, however, very materially reduce the labor of the enumerators, without in any serious degree reducing the value of the returns."

The instructions to enumerators for 1920 contain a list of 63 principal languages, and the enumerators are expected to report many others.

Of all the inquiries those relating to the place of birth and mother tongue of the parents and to occupations were the most difficult to answer. A large proportion of the census reports are based on information obtained from the housewife. In many cases the wife was not certain about the country of birth of her husband's father and mother, and there was a much greater uncertainty when the answers were given by a third party, as was frequently the case. This lack of knowledge coupled with the changes in the boundaries of European countries following the war has, I am afraid, caused a large margin of error in the statistics on this subject. The increase in the number of defective reports is largely confined to the immigrants from the central and southern European countries.

Although a detailed analysis of the foreign element of the population is very important, we are certainly trying to gather too much information through the general enumeration. In view of the imperative necessity of reducing the number of inquiries, we should certainly be justified in confining the questions to the birthplace and mother tongue of the person reported.

Some of the inquiries are apparently very simple and easily answered, but in reality they require the exercise of considerable discretion and a personal conference with the individual enumerated. The one on "Color or race" is a good example. To answer this the enumerator must determine not only whether the person is black or white, but whether he is a mulatto. There are cases in which the same family has been enumerated as black at one census and as mulatto at a subsequent census. The enumerator must further determine whether the person is an Indian, Chinese, Japanese, Filipino, Hindu, Korean, or "all other," and insert the proper symbol. Sometimes it is difficult to decide the nationality even after a personal inspection. In Charles City County, Virginia, there is a community of several hundred, remnants of the original tribe of Chickahominy Indians. The Indian strain is considerably diluted and the language is practically lost; nevertheless they contend that they should be reported as Indians. Other citizens of the county, however, declare that they are not Indians and should be reported as Negroes. Some of these men came to the office in Washington for the purpose of urging that all members of the so-called tribe be enumerated as Indians. Those that we saw certainly had pronounced Indian features; but the enumerators decided that not all of the tribe should be reported as Indians, and I imagine that no one can say just where the line of distinction was placed.

If the census were confined to a simple enumeration of the population with very limited information concerning its characteristics, the instructions to enumerators would be greatly reduced. It would then be much easier to obtain enumerators at the rates of pay the government is willing to offer.

There are many who look in holy horror at the suggestion to omit the inquiry concerning occupations. Since 1910 there has been a great amount of work done in the endeavor to perfect the census of occupations. Exhaustive lists of occupations have been prepared and the instructions for enumerators and for the office work carefully revised. The editing and tabulation have been made a distinctive feature and not carried on as a part of the individual census as heretofore. The editing of the schedules was started as rapidly as they could be released from the general population work. By November 15 there were 259 clerks engaged in the examination and the insertion of the symbols for the occupation punch cards. This force had been gradually and carefully built up, and we are in hopes that the statistics will be a more accurate presentation of our occupations than the office has been able to compile at any preceding census. The defects in the work, however, are fundamental. As in the case of the mother tongue, mistakes are made by the enumerators or by the persons who answer the inquiries. The returns for 1910 were bad enough, but it is my impression that those for 1920 were, in certain particulars, even more defective.

I fully appreciate the importance of statistics of mother tongue and occupations. At the same time, the population and industries of this country are growing at a constantly increasing rate. Industries are becoming more complex. The increase of 13,710,842 in our population that occurred during the past decade is necessarily accompanied by some corresponding ratio of increase in the agricultural, manufacturing, and other activities of the people. The time is rapidly approaching, if it is not now at hand, when there must be some radical changes made in our census methods. The suggestions that the time allowed for the work be indefinitely extended, that the pay of the supervisors and enumerators be materially increased, that more time and care be devoted to preparatory work, etc., are all good. They would probably result in a more scientific and instructive analysis of the data. But these changes would not enable the Bureau to meet the insistent demand for the publication of the results of the census shortly after the date to which they relate.

ANNOUNCEMENT OF POPULATION

It is impossible to give an explanation, satisfactory to the general public, of the reasons why the population of the United States cannot be announced until almost ten months after the date to which the figures relate; or why there is such a delay in the announcement of the totals for agriculture and manufactures. It is, or will shortly be, impossible to throw the census net over the entire population and all of their activities, bring the different corners into Washington, and there compile and announce the results as quickly as is desired. It will be necessary to subdivide and distribute the work. For example, the preliminary count of the population for which the total for the United States was published on October 7 was based on the count made by the supervisors, verified by a hand count in the office at Washington. The supervisor must count the number of individuals returned by each enumerator and state the total on the enumerator's pay voucher and also on a check slip accompanying his returns. When these reports reach the Washington office a rapid count is made by glancing over each sheet of the returns, and if the two counts agree, the total is accepted. With proper safeguards the totals could be assembled and made public by the supervisors before the work was sent to Washington. They would, of course, be preliminary and subject to revision, just as they are now. The method would have the great advantage of quick announcement, and would enable the supervisors to answer and dispose promptly of all criticisms of defective enumeration. Under the present method it is impossible in many cases to make an accurate check of the enumeration and to correct errors, if errors are found, because there are so many changes between the time of the count and the date of announcement.

The greatest reductions in the number of inquiries should be made in the schedules for agriculture and manufactures. Details on these subjects can be developed at the mid-decennial censuses and for manufactured products at the biennial enumerations. The entire omission of manufactures, and, if practicable, of agriculture also, from the decennial census would be an improvement. It would certainly enable greater accuracy and more rapid work in the enumeration of the population.

The principal processes involved in the taking of a census are the establishment by metes and bounds of the supervisors' and enumerators' districts (378 and 87,234 in number, respectively, at the Fourteenth Census); preparation of schedules and instructions; selection, appointment, and instruction of supervisors; selection, appointment, and instruction of enumerators and inspectors; distribution of blanks;

conduct of the enumeration; shipment of completed schedules to Washington; preliminary examination of schedules to see if all are received, and if there is any evidence of padding or irregularities; preliminary count of population; announcement of preliminary totals of population; disposition of requests for re-enumeration; editing schedules, or their preparation for the card-punching machines; punching the cards, verification of cards by machine and by personal inspection; verification of cards rejected by the machines; comparison of machine count with hand preliminary count; assortment of cards for machine tabulation; various runs of cards through tabulating machines; editing schedules for census of occupations; punching cards for occupations; machine tabulation of cards for occupations; preparation of final tables for printer.

USE OF MACHINERY

At this census machinery, both hand and power driven, is being used more extensively than at any preceding enumeration. It is employed in all three of the principal branches—population, agriculture, and manufactures. Necessarily, the processes differ in each branch; but they all are based on the same general principles.

The machines are not perfect or entirely satisfactory for census work. The punch used for the population card is the most unsatisfactory. The tabulating machine was developed in the Bureau, and is far in advance of any heretofore used. The commercial punch used in the work on agriculture and manufactures is not satisfactory because of the small number of items carried on each card. It requires 17 cards to carry all the items necessary to be punched from the agricultural schedule, and one for the live-stock schedule, thus increasing the number of cards to about 167,000,000.

This is the first time the card system has been used in the work on manufactures. Undoubtedly it will enable a more detailed presentation, but whether it will be as economical and lead to as early a publication as the systems used at prior censuses is questionable. The demand for more and more detail concerning the various products of manufacture has resulted in greatly extending the schedules. It has also encouraged the chief statistician in charge of the work to expand and indulge in a more elaborate presentation. I think this is a mistake. At the decennial periods the census of manufactures, if taken at all, should be greatly curtailed. It should, at least, be confined to the general schedule, and all supplemental special schedules omitted.

If the census of mines is taken in connection with that of manufactures, the line of demarcation should be more clearly defined than it was at preceding censuses. The separation of the statistics of manufactures and mining is complicated by the work of the Geological Survey. The Survey makes annually a census of mineral production, and, naturally, we should expect its totals for the decennial census years to agree with those compiled by the Bureau of the Census. This is especially true if the two bureaus work in coöperation, as they have at the past two or three censuses. The Survey, however, very properly includes in its total many products which are primarily the result of manufacturing processes and which are included in the census of manufactures. At the census of 1910 they were also included in the census of mines. In other words, there never has been a clear-cut distinction in the census between manufacturing and mining. I do not know that there is a practical line of separation that can be uniformly applied, but I do believe it is possible to devise a more satisfactory method than the one used at the census of 1910.

CHANGES IN PROCEDURE

Many changes were made in the order of procedure at this census as compared with prior censuses. The most important of these was the publication of the figures for the minor civil divisions of each county as quickly as they were ascertained. These figures were used to build up the state totals, which were then announced. In 1910 the county and state totals and those for cities having 5,000 or more inhabitants were announced, but no chance was given the public to criticise the figures for the smaller divisions. The change enabled us to give these figures to the persons interested and to receive their criticism in time to correct errors and make minor adjustments. Many complaints of defective enumeration were received. A few were well founded; in such cases the enumeration was checked and the corrected totals carried into the printed reports. In 1910 the office did not have the advantage of this advance criticism; the totals were, as a rule, published as final. It was too late to make changes in the figures for the minor divisions, and very little checking of the enumeration was done.

MARGIN OF ERROR

Most of the error in census reports is due to defective field work. The office is constantly endeavoring to reduce this margin of error by improving the instructions to enumerators and agents, and by a closer supervision of the field force. The error with respect to the number of inhabitants, number of farms, number of manufacturing establishments, etc., is comparatively small. It increases in the replies to the various inquiries on the different schedules. I believe that the greatest amount of error occurs in the replies to what are considered essential and well-constructed inquiries, but that relate to matters concerning which it is difficult for the enumerators to obtain information. The percentage of error increases with the difficulties encountered by the enumerators as well as with the number of questions. Practical experience in census taking is very helpful in the construction of schedules, and a wise discrimination in the selection of inquiries is essential to the success of the work.

The population of the United States was announced on October 7. This was twelve days later, relatively, than it was made public at the Thirteenth Census. This delay was owing to a change in methods which has resulted in a great deal of work being done before, which at the last census was done after, the announcement but before the publication of the bulletins. On October 7 the work was in far better shape to proceed with the publication of bulletins on population than it was at the corresponding date ten years ago.

CENSUS ADVISORY COMMITTEE

At this census the Bureau has had the privilege of conferring frequently with a committee composed of members of the American Statistical and American Economic Associations, and the advantage of their advice on all important matters. The committee has been consulted at every important stage of the work, and its recommendations have been almost uniformly followed. The committee has considered all the basic tables and many of the subsidiary ones. It has been mutually agreed that the text of the bulletins and reports shall be confined to the brief description of the tables, and that some of the tables contained in the reports of the Thirteenth Census shall be omitted from the Fourteenth Census, and many changes made in others. We shall retain all that is essential, and shall endeavor to put it in more logical form and to reduce the size of the reports. The state bulletins on population and agriculture that have been printed and distributed illustrate the character of the changes that have been made. For example, the bulletin for 1910 giving the number of inhabitants, by counties and minor civil divisions, for Massachusetts contained thirteen printed pages. The corresponding bulletin for 1920 has nine pages, and yet we believe it contains more essential statistics. There were two bulletins on agriculture for each state at the last census. At this census there will be but one.

A free discussion of policies and methods with trained men not in the federal service but who make constant use of government statistics cannot but be helpful to the service, and I hope the committee will be continued until the end of the census period.

PUBLICATIONS

The preliminary totals for the population of all states, counties, cities, and minor civil divisions had been published on or before October 7. There are a number of factors that may be compared in order to determine the relative progress of the work at the different censuses; the rapidity with which copy for the final reports is sent to the printer is the most definite. At the census of 1910 copy for the first bulletin, giving statistics of population by minor civil divisions for New Jersey, was sent to the printer just 10 months and 25 days after the beginning of the enumeration. The first bulletin of this character sent to the printer at the Fourteenth Census was for Porto Rico, and it was sent to the printer just 4 months after the beginning of the enumeration. Within 11 months and 5 days after the beginning of the enumeration at this census we had sent to the printer copy for these bulletins for 31 states, Porto Rico, Hawaii, Guam, and Samoa, making a total of 35 bulletins. At the preceding census copy for only 2 bulletins was sent to the printer within 13 months and 14 days. By December 31, 1921, copy for the last minor civil division bulletin was sent to the printer, just one year after the beginning of the enumeration, which compares with 1 year, 6 months, and 22 days for the last Thirteenth Census bulletin of this character. For agriculture, copy for bulletins on 10 states has been sent to the printer, while none had been sent to the printer at the corresponding date of the Thirteenth Census. The tables for the second series of bulletins—those on the composition and characteristics of the population—have been established, and we shall soon begin to send copy to the printer for the different states. These bulletins will complete the reports in which the state is the primary unit. The final volumes on population will contain further details for certain subjects, such as race, nativity, age, marital condition. In these the classification is based on the subject, and the states, cities, and counties are subsidiary. In like manner the report on agriculture will contain special reports on race, nativity, and tenure of farmers, on live stock, selected crops, etc. Two series of reports will be published for manufactures, one by states and the other for selected industries.

CONCLUSIONS

The work has hardly proceeded far enough to enable us to say definitely how it will compare with preceding censuses in accuracy, dispatch, and cost, but the stages that have been completed, I believe, justify the following conclusions:

1. Either the period fixed by law for the completion of the census must be extended or the scope of the work greatly curtailed.
2. It was a mistake to advance the date of enumeration from April 15 to January 1.
3. Greater care should be taken to perfect the preliminary work.
4. The enumerators' districts should be finally and definitely described and established sufficiently in advance of the appointments to insure a proper understanding of the boundaries.
5. All schedules and instructions should be greatly reduced.
6. Manufactures and mining should be omitted from the decennial census or the inquiry limited to the number of persons engaged and the production; this on the understanding that there will be a complete census of manufactures at regular intervals during the intercensal periods.
7. Supervisors should be trained employees and not temporary appointees.
8. The preliminary count of the population for counties, cities, and minor civil divisions should be made in the offices of the supervisors and announced by the supervisors.

By the establishment of a permanent census office almost twenty years ago, the federal government definitely committed itself to a permanent program for census work. It has failed, however, to place in the Bureau the authority to establish a satisfactory organization, and to provide for the elimination of duplication in work of a similar character being carried on by other federal bureaus. These bureaus are constantly coming in contact over questions that never can be satisfactorily settled until the collection of statistics is centralized and a radically different scheme of organization established.

The Department of Agriculture collects data and compiles estimates pertaining to questions covered by the decennial and intercensal inquiries of the Census Bureau. Frequently the results of the census are not entirely satisfactory to the officials of the Department of Agriculture, and it endeavors to verify or establish the margin of error in census reports.

The United States Geological Survey makes an annual census of the production of minerals, and collects other statistics concerning our mineral industries. This comes in contact with our decennial census of mining.

The Bureau of Internal Revenue compiles statistics of the consumption and stocks of tobacco, which come in contact with those compiled by the Bureau of the Census.

Still other examples could be given of the lack of coōrdination in the statistical work of the bureaus. This condition, and the need of a better organization, covering the entire United States, looking to the collection of data concerning the population, resources, and industries of the country, lead to the conclusion that some scheme should be worked out for the appointment of local representatives in different states or sections of states who would attend to all statistical work required by the federal government. Such an organization, if properly formed and placed under the supervision of one bureau, would go far toward eliminating the unsatisfactory features of the present system or lack of system. I believe that some scheme of this character was in the mind of Congress when it established the permanent Census Bureau, and I am in hopes that it will again be revived and carried into effect.

INDUSTRIAL ESTABLISHMENT DISABILITY RECORDS AS A SOURCE OF MORBIDITY STATISTICS*†

By Edgar Sydenstricker and Dean K. Brundage, *United States Public Health Service*

Epidemiology is yet an undeveloped science largely because it lacks the basic data which it must draw from the field of vital statistics. Clinical medicine and bacteriology have made available a large body of material for its use, but since the epidemiological method is essentially the statistical method and epidemiological data are chiefly statistical data, the growth of this new branch of knowledge has so far been one-sided. We cannot hope for its uniform development until accurate and complete statistics of disease incidence in different population groups and under varying conditions of environment are collected currently and in considerable detail.

The statistics of disease incidence which are now available are confined almost entirely to deaths. The grave shortcomings of mortality data as the basic data for statistical research in disease incidence have not, perhaps, been sufficiently realized. In fact, the statement may be ventured that we have been too satisfied with and have attached too much importance to epidemiological conclusions based upon data which relate to only one phase of disease incidence. We are yet greatly in the dark with regard to even the most important facts concerning predisposition to disease, the conditions under which disease begins, and the circumstances which affect or control its course in a population. What we need, what we must have, before satisfactory progress can be made, are morbidity data.

This has been said so often that it has become trite. May it not be said that we have fallen more or less into the habit of regarding complete and accurate morbidity statistics as an impracticable ideal, as a goal impossible of attainment? Is there not in such an attitude this element of danger—a tendency to relax in the endeavor to obtain the desired data simply because they cannot be obtained at once and with the methods which we are accustomed to use in recording mortality?

Before bringing to your attention a possible field for morbidity research, a brief consideration of the situation with regard to morbidity statistics seems pertinent.

The data upon which morbidity statistics are now based necessarily are less uniform, less complete, and less accurate than those which are the foundation of mortality statistics. A death is an event of which the local public, in the performance of certain governmental functions and in the observance of certain social conventions, must take cognizance. The fact that a citizen has ceased to live is usually recorded: at least, some statement of the cause of his demise is placed upon the public books, and certain facts as to his nativity, sex, age, marital condition, residence, occupation, and the like are ascertained. His remains cannot be disposed of until these things are done. We have, therefore, a set of mortality records which are gradually becoming more uniform, more complete, and more accurate. An illness, on the other hand, is a commonplace happening unless the affected individual is regarded as a menace to the community. A case of leprosy, of typhus fever, of bubonic plague, or even of smallpox or scarlet fever, is important enough in the public mind as a source of danger to be reported and isolated. But a disability resulting from tuberculosis or from a non-communicable disease equally as serious to the individual and, indirectly, to the community is such an every-day affair that only by the most searching inquiry can its occurrence be ascertained and recorded.

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* From the Statistical Office, United States Public Health Service.

† Read at the Eighty-second Annual Meeting of the American Statistical Association, Atlantic City, New Jersey, December, 1920.

The obstacles actually encountered in obtaining morbidity reports for a given population or population groups are well known to vital statisticians. The chief difficulties may be expressed in three statements:

(1) Only such diseases can be reported as come to the attention of physicians and other diagnosticians. These diseases ordinarily are brought to their attention only at a stage when discomfort, pain, or disability is experienced; in their incipient and latent stages, when they are not noticed even by the individual affected or do not interfere with his normal activities, but when their importance is equally as great or even greater, they are not reported.

(2) Only such cases are reported as are (a) notifiable under the law, and of these (b) only the ones that the physician or other reporting agency is willing to report.

(3) Even when the occurrence of an illness is reported, the diagnosis is frequently less accurate than a statement of cause of death. This is inevitably so for the reasons that the illness itself may be merely a symptom of one or several diseases, that it is not always practicable to apply established tests, and that the individual affected cannot be under sufficiently close observation to obtain the necessary clinical evidence.

How, then, are we ever to obtain the necessary material for statistical analysis or epidemiological research?

Let us examine, for a moment, the possible sources of morbidity data. Keeping in mind the fact that the occurrence of disease in a population for which certain facts as to race, sex, age, and various environmental conditions can be known, is the goal, we may classify the various sources into three general groups, as follows:

1. Reports of diseases that are "notifiable" under law, which are made by physicians and other diagnosticians to health authorities.
2. Disability or sickness records for persons associated into insured groups, for persons employed in certain industrial establishments maintaining fairly detailed supervision of the health of their employees, for persons living in various institutions, and in the armed forces of the United States.
3. Special surveys of observed groups of persons that are made with the specific purpose of obtaining accurate records of the incidence of a given disease. These studies are, of course, researches in their purpose and character.

It will be seen at once that the first source of material mentioned—the reports of certain notifiable diseases which have accumulated in every health department—does not begin to satisfy the elementary requirements for statistics of disease incidence. The reports are by no means complete for any disease, even assuming the diagnosis to be trustworthy. They do not contain accurate or sufficient data regarding conditions under which the disease occurs. The decennial enumeration of the population as to specific occupation, for example, cannot be utilized, and the cases are not reported for any definitely enumerated population from any point of view. The third source of material obviously is of a special kind, and its scope and its usefulness are limited only by the amount of money and time spent and by the ability of those who are making the research. The second group of sources of data, on the other hand, afford at the present time more encouragement of a practical sort for obtaining *current* facts as to disease incidence for a definitely known exposure under a limited number of important conditions than either health department records or the results of special surveys.

In this belief, the attempt is being made by the statistical office of the Public Health Service to collect current records of disability (exclusive of those due to industrial accidents) occurring among employees of industrial establishments. The project was planned with the assistance of a committee of the American Public Health Association.*

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* The plan for standardized sickness records and reports is contained in the following Public Health Reports:

1. *Report of Committee on Industrial Morbidity Statistics*, Reprint No. 484.
2. *Continuation Report of the Committee on Industrial Morbidity Statistics*, Reprint No. 564.
3. *Sickness Records for Industrial Establishments*, Reprint No. 573.
4. *Diseases Prevalent among Steel Workers in a Pennsylvania City*, Issue of December 31, 1920.

Since very few plants maintain records of specific causes of disability among their employees, it was necessary to utilize records of such sick-benefit associations of employees as were willing to conform to a standard system of records and reports. These records show for each case of disability the date on which cash "benefits" commenced (usually the third, fifth, or seventh day of disability), the number of days for which benefits were paid, and the cause of disability as stated on a physician's certificate. At the present time, about sixty such associations are coöperating with the Public Health Service, although not all of them have made the changes in their method of recording and reporting disabilities that are necessary to conform to either of the "standard" methods suggested by the committee and the Public Health Service. The total membership of these associations at last report was approximately 250,000; because of reductions in force, this "exposure" will probably be considerably decreased. Two standard methods of recording and reporting disabilities were proposed to industrial establishments and sick-benefit associations in order to secure their sickness experience as well as to assist them in utilizing and analyzing their own records as a basis for preventive work. (1) One method requires a record of the number of persons considered by sex and occupation (or department within the plant), and a record of every case of disability for which sick benefits are paid, showing the date of onset (*i. e.*, the date on which disability commenced), duration (*i. e.*, the number of days for which sick benefits were paid), diagnosis, and occupation (or department) in which the disabled person is employed. (2) The other plan includes not only the data required in (1) but also contemplates a greater amount of detailed information, such as the age, race, length of time in occupation, etc., for both the persons considered and the cases of disability among such persons. The latter plan requires a rather detailed system of individual cards and only a few plants are at present in a position to put it into effect.

Although the work of utilizing these records, after placing them on either of the so-called standard plans, is still in an experimental stage and the policy of retrenching as much as possible on all expenditures for records is being practiced in industrial plants generally at the present time, it is believed that the use of such records can be developed to serve two important purposes: (1) to furnish fairly current information regarding the incidence of disease among a representative group of wage-earners in different industries, and (2) to accumulate a mass of data relating to the causes of disability among a large number of adult persons of different race, sex, age, and occupation and industry.

Since the plan has been inaugurated only a few months, the material so far collected is not sufficient to warrant definite conclusions on any of the essential points. The data cannot be presented here in detail, but for purposes of illustration we will call attention to two tabulations. One shows the monthly variation in diseases which caused disabilities of seven days or longer in a group of plants during the first eight months of 1920; the other shows the incidence of various diseases causing a disability of more than one day during a 12-month period in a large industrial plant.

Taking up first the monthly variations in disease incidence among the members of certain sick-benefit associations of employees in a group of industrial establishments: The number of persons considered varied from 14,208 in January to 62,757 in July, and the number of industrial establishments from 8 in January to 25 in July. The annual incidence rates per 1,000 persons for sicknesses causing inability to work for seven days or longer by months were as follows: January 275, February 327, March 126, April 103, May 77, June 67, July 67, August 54. An extremely wide seasonal variation thus is manifested, the rate for February being approximately six times the rate for August. It will be recalled that the recrudescence of epidemic influenza occurred in the first three months of 1920, particularly in February, and in order to find out to what extent the epidemic influenced the seasonal variation in disease incidence, the following table and graph were prepared, showing the monthly incidence rates of influenza and grippe in comparison with the rates for the principal disease groups. Cases diagnosed either as influenza or as grippe were combined, because the terms were often used interchangeably in reporting the epidemic.

In the first two months of the year the frequency rate for influenza and grippe, it is seen, was larger than the frequency rate for all other diseases combined; in March, however, the number of new cases of influenza and grippe dropped perceptibly below the rate for all other diseases, and gradually diminished to the negligible incidence of 0.8 cases per 1,000 in July. The occurrence of the epidemic in the months in which sickness ordinarily is heavy accentuated markedly the usual seasonal variation. Even with influenza and grippe eliminated from the sickness rates, disease occurrence was about twice as frequent in winter as in summer.*

When influenza and grippe are subtracted, there still remains a surprisingly high frequency rate of sickness causing disabilities of seven days or longer. In January this rate was 132 new cases per 1,000 persons on an annual basis, and even in August, the month of lowest

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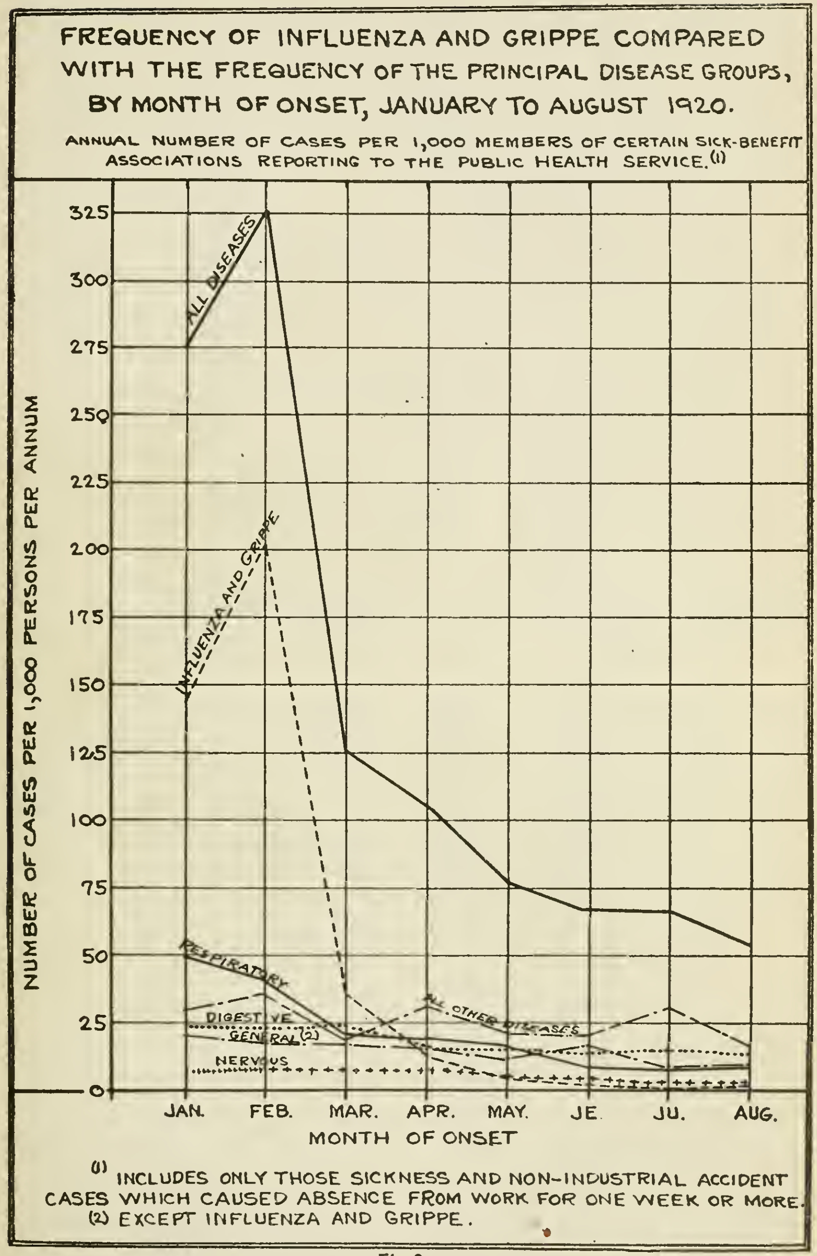
* In regard to the more important diseases and groups of diseases occurring each month, it should be stated that the monthly fluctuations in their incidence, presently to be discussed, were indicated in a general way for each reporting association.



FREQUENCY OF INFLUENZA AND GRIPPE COMPARED WITH THE FREQUENCY OF THE PRINCIPAL DISEASE GROUPS, BY MONTH OF ONSET, JANUARY TO AUGUST 1920.

ANNUAL NUMBER OF CASES PER 1,000 MEMBERS OF CERTAIN SICK-BENEFIT ASSOCIATIONS REPORTING TO THE PUBLIC HEALTH SERVICE.(1)

(1) INCLUDES ONLY THOSE SICKNESS AND NON-INDUSTRIAL ACCIDENT CASES WHICH CAUSED ABSENCE FROM WORK FOR ONE WEEK OR MORE.
(2) EXCEPT INFLUENZA AND GRIPPE.

Fig. 2.

TABLE I

FREQUENCY OF INFLUENZA AND GRIPPE COMPARED WITH THE FREQUENCY OF THE PRINCIPAL DISEASE GROUPS, BY MONTH OF ONSET, JANUARY TO AUGUST, 1920*

Month of onset	Number of associations reporting	Membership	Number of cases per 1,000 persons per year							
			All diseases and conditions	Influenza and grippe	Other diseases and conditions					
					Total	Diseases of respiratory system	Diseases of digestive system	General diseases†	Diseases of the nervous system	All other diseases
January	8	14,208	275.0	142.9	132.1	49.9	24.1	20.8	7.5	29.8
February	13	22,249	326.7	201.4	125.3	40.8	22.7	17.5	8.5	35.8
March	14	23,527	126.0	37.1	88.9	21.1	24.1	17.1	8.0	18.6
April	18	30,075	103.4	13.2	90.2	19.4	15.6	16.6	8.0	30.6
May	22	58,302	76.7	4.6	72.1	16.8	15.3	12.2	5.9	21.9
June	25	62,344	67.1	2.3	64.8	9.2	14.1	15.8	5.0	20.7
July	25	62,757	67.3	.8	66.5	8.1	15.2	8.7	3.8	30.7
August	24	60,304	54.4	1.1	53.3	9.1	13.9	9.4	3.8	17.1

* Annual number of cases per 1,000 members of certain sick benefit associations reporting to the Public Health Service. Only cases lasting 7 days or longer are included.

† Except influenza and grippe.

incidence in the 8-month period, the annual rate was over 50 per 1,000. This is true in spite of the fact that the members of a large proportion of the associations are a selected group.*

In lieu of a more satisfactory basis for classifying the diseases, and in accordance with the recommendations of the American Public Health Association's committee, the groupings appearing in the International List of the Causes of Death have been utilized in our tabulations. On this basis, the outstanding causes of disability are found in the "general" (from 10 to 164 per 1,000), the "respiratory" (from 8 to 50 per 1,000), and the "digestive" (from 14 to 24 per 1,000), these three groups accounting for from 49 to 86 per cent of all disabilities lasting seven days or longer. The wide fluctuation in the general diseases was caused almost entirely by influenza and grippe. Rheumatism does not show so great a seasonal fluctuation as might have been expected; the rate from this cause was high during the period January–June, showing a slight tendency to become less frequent in July and August. The tuberculosis rate varied between 1 and 3 per 1,000 persons per year which seems to indicate a relatively slight disability from tuberculosis lasting seven days or longer. It may be offered in explanation that many cases which actually began in the period under consideration probably had not yet reached a stage involving actual incapacity for work.

It is interesting to note that occupational poisonings are almost entirely absent in this list as a cause of disability. Two possible reasons for this fact may be advanced: (a) That poisonings do not ordinarily incapacitate for as long as seven days, and (b) that they are not accurately diagnosed. The group of respiratory diseases, as may be expected, exhibits a marked seasonal fluctuation. This variation is true of each and all of the diseases in this group, the disabilities caused by bronchitis and pneumonia being the outstanding features. The relatively high rate from the digestive diseases in the first three months of the year is accounted for chiefly by diseases of the pharynx, of which

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* Twelve of the 27 associations specify definite age limits for eligibility to membership, the average limits being from 17 to 55 years of age. In some other respects, too, industrial employees are a distinctly selected group. Temporary or casual laborers are seldom admitted to membership, and some may be too poor to afford the cost of insurance. Women have not the privilege of belonging to some of the reporting associations, and in those reporting associations which do have female members their number is relatively small, so that the sickness rates presented could not be affected to any appreciable extent by the greater frequency of illness among women. Furthermore, not all diseases are included in the tabulations, as sick benefits are denied for the venereal diseases, and six of the 27 reporting associations in this group refuse to pay benefits for chronic diseases contracted prior to the date of joining the association. Sixteen of the associations do not pay for disabilities brought on by the use of intoxicating liquors; eleven decline to pay for disabilities resulting from the violation of any civil law; and eight for the results of wilful or gross negligence. Just how rigidly these rules are enforced is not known, but, considering these restrictions, the statistics should be regarded as a *minimum* statement of the disabilities actually occurring and lasting seven days or longer.

TABLE II

ANNUAL NUMBER OF CASES OF SICKNESS CAUSING DISABILITY FOR ONE WEEK OR LONGER PER 1,000 MEMBERS OF SICK-BENEFIT ASSOCIATIONS IN CERTAIN INDUSTRIAL ESTABLISHMENTS REPORTING TO THE PUBLIC HEALTH SERVICE: BY MONTH OF ONSET, JANUARY TO AUGUST, 1920, AND BY DISEASE CAUSING DISABILITY

Disease or condition causing disability (with corresponding title numbers in parentheses from the International List of the Causes of Death)	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.
All Diseases and Conditions..........(a)	275.0	326.7	126.0	103.4	76.7	67.1	67.3	54.4
General Diseases......................	163.7	218.9	54.2	29.8	16.8	18.1	9.5	10.5
Typhoid fever...................(1)	1.7	...	.5	.5	.4	..	.4	.6
Influenza and grippe..............(10)	142.9	201.4	37.1	13.2	4.6	2.3	.8	1.1
Tuberculosis of the lungs..........(28)	2.5	1.1	3.0	.9	.9	2.3	1.2	1.3
Cancer—all forms.............(39–46)	...	1.1	.5	.9	.7	...	.6	.8
Rheumatism..................(47, 48)	6.6	6.8	5.5	7.6	5.0	6.7	3.0	3.6
Occupational poisonings.......(57, 58)	...	...	...	...	...	.2	...	...
Others ...(2–9, 11–27, 29–38, 49–56, 59)	10.0	8.5	7.5	6.6	5.2	6.5	3.4	3.2
Diseases of the Nervous System.........	7.5	8.5	8.0	8.0	5.9	5.0	3.8	3.8
Neuralgia and neuritis............(73)	4.2	2.8	2.0	.5	1.7	.8	1.4	1.3
Cerebral hemorrhage, apoplexy and paralysis.....................(64–66)	.8	...	.5	.5	.2	.2	.2	...
Insanity....................(67, 68)	.8	1.1	1.5	.5	.2	.2	...	.6
Others..............(60–63, 69–72, 74)	1.7	2.3	3.0	4.3	1.5	2.3	1.6	1.5
Diseases of the eyes..............(75)	...	.6	...	1.9	1.5	1.1	.4	.4
Diseases of the ears...............(76)	...	1.7	1.0	.5	.7	.4	.2	...
Diseases of the Circulatory System.......	2.5	5.1	4.5	3.3	4.8	2.9	4.0	2.1
Diseases of the heart...........(77–80)	1.7	2.3	1.0	1.4	1.7	1.1	2.2	1.1
Diseases of the veins.............(83)	.8	2.3	2.5	1.4	1.7	1.5	1.4	.6
Others.................(81–82, 84–85)	...	.6	1.0	.5	1.3	.4	.4	.4
Diseases of the Respiratory System.......	49.9	40.8	21.1	19.4	16.8	9.2	8.1	9.1
Bronchitis....................(89, 90)	21.6	19.3	12.0	8.5	6.3	3.2	3.8	3.4
Pneumonia...................(91, 92)	15.8	12.5	2.5	4.7	5.0	1.9	1.6	1.9
Others................(86–88, 93–98)	12.5	9.1	6.5	6.1	5.5	4.2	2.6	3.8
Diseases of the Digestive System.........	24.1	22.7	24.1	15.6	15.3	14.1	15.2	13.9
Diseases of the pharynx..........(100)	15.0	12.5	10.0	7.1	5.5	4.0	3.4	3.4
Diseases of the stomach......(102, 103)	4.2	5.1	5.5	3.8	3.1	2.9	4.4	3.6
Diarrhea and enteritis............(105)	1.7	1.1	2.0	...	...	1.3	1.0	1.9
Appendicitis...................(108)	3.3	2.3	2.5	1.9	2.8	2.5	3.4	3.0
Hernia.......................(109)	...	1.1	1.0	2.4	2.4	2.1	.8	1.1
Others......(99, 101, 106, 107, 110–118)	...	.6	3.0	.5	1.5	1.3	2.0	1.1
Diseases of the Genito-Urinary System ...	2.5	3.4	.5	1.4	1.7	1.1	1.4	.6
Acute nephritis and Bright's disease (119, 120)	2.5	.6	...	...	...	.6	...	...
Others...................(121–133)	...	2.8	.5	1.4	1.7	.4	1.4	.6
The Puerperal State..................	...	...	...	...	...	...	...	...
Diseases of the Skin and Cellular Tissue...	5.8	7.4	2.5	5.2	2.2	2.7	4.9	2.5
Furuncle.......................(143)	3.3	3.4	1.5	3.8	.7	1.3	2.6	.6
Others................(142, 144, 145)	2.5	4.0	1.0	1.4	1.5	1.5	2.2	1.9
Diseases of the Bones and Organs of Locomotion	4.2	1.7	3.0	2.4	3.7	1.7	2.4	2.3
Diseases of the bones............(146)	.8	.6	...	.5	.7	...	.2	.4
Diseases of the joints............(147)	...	...	1.5	.5	1.1	.4	.8	.2
Others...................(148, 149)	3.3	1.1	1.5	1.4	2.0	1.3	1.4	1.7
Senility............................	...	...	...	...	...	...	...	...
External Causes..............(155–186)	3.3	10.8	2.5	13.2	6.1	7.6	12.1	6.3
Ill-Defined Diseases and Conditions (187–189)	11.6	7.4	5.5	5.2	3.3	4.6	5.7	3.2

(a) Except those mentioned in the footnote on p. 591.

tonsillitis is the most important. Disability due to tonsillitis is shown to be astonishingly great. Eliminating pharyngeal affections, the digestive diseases exhibit a fairly constant rate throughout the 8-month period. Seasonal disabilities arising from these causes do not show the anticipated increase in the summer months.

TABLE III

ANNUAL NUMBER OF CASES OF SICKNESS PER 1,000 FOR ALL REPORTING SICK-BENEFIT ASSOCIATIONS, AND FOR EACH REPORTING ASSOCIATION HAVING MORE THAN 500 MEMBERS, BY MONTHS, JANUARY TO AUGUST, 1920[a]

(Where blank spaces appear the statistics were not available)

Sick-benefit associations	Average membership	Number of cases per 1,000 persons per year							
		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.
All reporting associations	41,721	275	327	126	118[b]	80[b]	71[b]	74[b]	59[b]
Group I[c]	34,936	266	283	118	109	71	67	67	55
A	8,528	170	118	60	45	26	38	36	38
B[d]	2,890	548	785	252	175	150	119	120	...
C	6,813	...	272	133	102	77	61	75	53
D	4,125	...	...	...	...	108	101	98	72
E	18,671	...	...	...	...	61	52	46	59
F	3,169	...	...	...	...	...	64	48	40
G	5,286	...	...	...	...	59	65	62	17
H	4,301	...	...	...	204	125	130	170	112
Group II[e]	4,858	362	616	130	120	133	97	101	78
N	879	270	620	148	70	136	70	146	131
O	553	...	461	83	153	43	44	21	21
P	626	527	648	200	151	203	137	39	119
Q	697	328	700	152	157	135	122	101	118
R	1,134	...	...	85	55	94	76	101	51
S	1,193	...	...	...	175	190	97	191	30
T	922	...	...	...	113	111	133	133	95
Others[f]	1,927	132	338	212	208	145	115	154	92

[a] Includes only those sickness and non-industrial accident cases which caused absence from work for one week or longer.

[b] Rate for all reporting associations from April to August differs from the rate for all diseases shown in Table II, because association H, which does not report diagnosis, is included in this table.

[c] Associations which have more than 3,000 members.

[d] Included with the large associations because the membership is nearly 3,000.

[e] Associations which have less than 3,000 members.

[f] Associations which have less than 500 members.

When the frequency rates from all diseases are compared for establishments (see Table III), extraordinarily wide differences are shown in every month. In February, for instance, the frequency rate for association A was 118 per 1,000, while for association B it was 785 per 1,000; and in July Association H had nearly five times as much sickness as Establishment A. It was observed that similar differences appeared in the rates among the smaller associations. These marked differences afford strong reasons for a careful study not only of the causes of illness in the different plants, but of the conditions which give rise to them. Although it is not the purpose to analyze these differences at this time, since the records for the different associations are not sufficiently comparable with respect to the period covered, the value of statistics of this nature will, it is believed, become more and more manifested as they accumulate.

As an example of the data afforded by records of sickness causing a disability of *one* day or longer, we present a tabulation of the experience of a rubber manufacturing company employing 18,000 persons during the year ending October 31, 1920. Although this company endeavors to obtain the diagnosis of each case of illness by requiring employees resuming work after illness to check in through the medical department, there were a large number of unclassified cases. The illnesses for which no diagnoses were recorded, however, were of short duration, the average being less than 3 working days. It may be assumed, accordingly, that the more serious diseases have been properly classified, and that the unclassified cases probably are mostly colds, headache, constipation, dysmenorrhea, and other conditions that disable for only two or three days. The cases for which no diagnosis was recorded constituted 36 per cent of the male cases and 42 per cent of the female cases, and since the difference is slight, it is believed that comparisons of the recorded diseases according to sex are sufficiently accurate for all practical purposes.

This experience shows a frequency rate of sickness, based on reported cases which terminated within the year, of 1,933 per 1,000 among 16,400 male employees on the factory payroll (office workers not having been included in the record). This is virtually two cases of disabling sickness per man per year. The rate for the 1,625 female factory workers was considerably higher—*i. e.*, 2,565 cases per 1,000.

In view of the estimate of 6.9 working days as the average loss of time per person per year, based on the sickness surveys of the Metropolitan Life Insurance Company in 1916 and 1917, it is interesting to find that the number of work days lost in the rubber manufactory during the year ending October 31, 1920, was 9.3 per male employee, and 13.8 per female employee. The average duration of disability was found to be 4.8 working days per male case, and 5.4 working days per female case. The women, therefore, not only were sick oftener, but failed to recover as rapidly as the men.

Considering first the incidence of the principal groups of diseases among persons of different sex, the statistics for this company show that the frequency of incapacitating illness was greater among the females for all disease groups except diseases of the circulatory system, diseases of the skin, and diseases of the bones, and in each of these three groups the number of female cases was not large enough to be conclusive, but only suggestive of the possibility that a larger number of cases might show the same results. The severity of disease as measured by

TABLE IV

PREVALENCE OF DISABLING DISEASES AMONG EMPLOYEES OF A LARGE RUBBER COMPANY DURING THE YEAR ENDING OCTOBER 31, 1920

Based on reported cases which caused absence from work for one day or longer and which terminated within the year.

Disease or condition causing disability (with corresponding title numbers in parentheses from the International List of the Causes of Death)	Cases per 1,000		Days lost per case		Days lost per person	
	Males	Females	Males	Females	Males	Females
All Diseases and Conditions	1933.0	2565.3	4.81	5.38	9.30	13.80
I General Diseases	275.1	297.2	9.79	12.16	2.69	3.61
Typhoid fever (1)	.5	...	41.25	...	.02	...
Malaria (4)	1.5	4.3	5.04	4.57	.01	.02
Smallpox (5)	3.0	3.7	13.61	12.00	.04	.04
Measles (6)	9.9	14.7	11.81	16.29	.12	.24
Scarlet fever (7)	7.8	16.0	18.47	28.77	.14	.46
Diphtheria and croup (9)	1.0	5.5	7.94	6.33	.01	.04
Influenza and grippe (10)	172.5	180.2	7.21	8.22	1.24	1.48
Dysentery (14)	2.6	2.5	2.21	3.50	...	.01
Erysipelas (18)	1.5	3.1	17.80	17.40	.03	.05
Mumps (19)	18.5	14.8	10.06	11.96	.19	.18
Chicken pox (19)	.6	.6	8.90	5.00	...	...
Infections (20)	9.6	15.4	7.73	5.60	.07	.09
Tuberculosis of the lungs (28)	2.6	2.5	60.86	235.25	.16	.58
Acute miliary tuberculosis (29)	2.0	2.5	47.94	36.00	.10	.09
Tuberculosis of other organs (30–35)	.4	...	38.00	...	.01	...
Syphilis (37)	1.8	3.1	24.13	30.00	.05	.09
Gonococcus Infection (38)	6.1	3.1	9.72	14.60	.06	.04
Cancer—all forms (39–46)	1.0	..	54.50	...	.05	...
Rheumatism (47, 48)	31.1	24.0	10.73	7.46	.33	.18
Diabetes (50)	.2	...	59.25	...	.02	...
Exophthalmic goiter (51)	.2	.6	45.00	16.00	.01	.01
Anaemia (54)	.5	...	70.13	...	.03	...
Alcoholism (56)	.2	...	3.33	...	...	...
Chronic poisonings (57–59)	...	...	...	...	...	...
Other general diseases	...	.6	...	16.00	...	.01
II Diseases of the Nervous System	36.2	40.0	7.67	7.06	.28	.28
Cerebral hemorrhage, apoplexy, and paralysis (64–66)	...	...	...	...	...	...
Mental alienation (67–68)	.4	.6	22.84	6.00	.01	...
Epilepsy (69)	.4	...	6.29	...	...	...
Chorea (72)	...	1.2	...	7.50	...	.01
Neuralgia and neuritis (73)	6.8	12.3	5.71	5.65	.04	.07
Sciatica (73)	1.8	1.2	22.24	30.50	.04	.04
Other diseases of the nervous system	...	...	29.00	...	...	...
Diseases of the eyes (75)	13.7	16.7	5.09	4.52	.07	.07
Diseases of the ears (76)	13.1	8.0	8.94	10.92	.12	.09
III Diseases of the Circulatory System	12.2	9.1	9.05	26.47	.11	.24
Endocarditis and other organic heart diseases (78, 79)	1.3	1.8	17.50	90.33	.02	.17
Hemorrhoids (83)	5.2	1.2	7.92	11.50	.04	.01
Other diseases of the veins (83)	.5	1.2	11.13	17.50	.01	.02
Other diseases of the circulatory system	5.2	4.9	7.82	8.50	.04	.04
IV Diseases of the Respiratory System	279.2	314.4	4.59	6.17	1.28	1.94
Excessive colds (86)	195.8	219.0	3.31	3.91	.65	.86
Other diseases of the nasal fossae (86)	20.7	26.5	3.73	4.35	.08	.12
Diseases of the larynx (87)	5.2	6.8	3.41	6.45	.02	.04
Bronchitis (89, 90)	43.1	37.5	7.95	16.18	.34	.61
Pneumonia (91, 92)	6.2	11.7	14.98	20.79	.09	.24
Pleurisy (93)	6.8	11.7	9.24	6.00	.06	.07
Asthma (96)	1.2	.6	30.65	2.00	.04	...
Other diseases of the respiratory system	.2	.6	12.00	3.00	...	...
V Diseases of the Digestive System	394.3	422.2	4.51	5.68	1.78	2.40
Diseases of the mouth (99)	12.9	23.4	3.63	5.95	.05	.14
Tonsillitis (100)	171.7	238.8	4.99	6.29	.86	1.50
Other diseases of the pharynx (100)	19.5	4.3	3.09	2.86	.06	.01
Ulcer of the stomach (102)	.4	.6	31.43	6.00	.01	...
Other diseases of the stomach (103)	84.1	68.3	3.20	3.80	.27	.26
Diarrhoea and enteritis (105)	26.7	25.2	3.03	3.07	.08	.08
Appendicitis and typhlitis (108)	11.2	13.6	14.79	16.18	.16	.22
Hernia (109)	4.1	1.8	21.93	12.33	.09	.02
Constipation (110)	37.3	12.3	2.56	2.10	.10	.03
Other diseases of intestines (110)	24.5	30.2	3.24	3.18	.08	.10
Biliary calculi (114)	.2	.6	7.33	3.00	...	...
Other diseases of the digestive system	1.7	3.1	10.57	13.00	.02	.04

TABLE IV—*Continued*

Disease or condition causing disability (with corresponding title numbers in parentheses from the International List of the Causes of Death)	Case per 1,000		Days lost per case		Days lost per person	
	Males	Females	Males	Females	Males	Females
VI Diseases of Genito-Urinary System....	5.4	190.1	14.35	5.71	.08	1.09
Nephritis and Bright's disease (119, 120)	.8	5.5	28.21	56.56	.02	.31
Diseases of the bladder...........(124)	1.2	7.4	5.68	4.08	.01	.03
Diseases of the testicles...........(127)	2.7	...	7.38	...	.02	...
Uterine hemorrhage ....(128)	...	12.3	...	16.70	...	.21
Dysmenorrhea..................(130)	...	151.4	...	2.58	...	.39
Other diseases of female genitals........	...	13.5	...	10.82	...	.15
Other diseases of genito-urinary system..	.7	...	40.18	..	.03	...
VII The Puerperal State...............	...	16.6	...	24.93	...	.42
VIII Diseases of the Skin...............	51.5	25.8	5.62	6.38	.29	.16
Gangrene......................(142)	.1	.6	4.00	4.00	...	...
Furuncle......................(143)	27.4	3.7	4.79	3.50	.13	.01
Acute abscess..................(144)	5.2	9.9	8.93	6.94	.05	.07
Rash-benzine..................(145)	5.1	2.5	7.48	4.00	.04	.01
Other diseases of the skin.............	13.7	9.1	5.34	7.73	.07	.07
IX Diseases of the Bones and Organs of Locomotion......................	41.1	22.7	5.10	6.24	.21	.14
Diseases of the bones.............(146)	1.2	.6	10.79	55.00	.01	.03
Diseases of the joints.............(147)	.8	.6	7.15	7.00	.01	.01
Lumbago......................(149)	13.2	3.7	5.43	8.00	.07	.03
Myalgia......................(149)	20.5	14.8	4.12	4.08	.09	.06
Flat feet......................(149)	4.6	1.8	7.08	6.00	.03	.01
Other diseases of the bones, and organs of locomotion....................	.8	1.2	3.14	2.50	...	...
XII Senility........................	..	...	147.00	...	.01	...
XIII External Causes	45.6	48.6	7.52	6.81	.34	.33
Poisoning by food or drugs........(164)	.4	3.7	5.20	6.83	...	.02
Fractures......................(185)	.9	2.5	23.27	23.75	.02	.06
Other injuries..................(186)	44.3	42.4	7.21	5.83	.32	.25
XIV Ill-Defined......................	792.4	1178.6	2.82	2.71	2.23	3.19
Headache....................(2–189)	87.4	94.8	2.63	3.20	.23	.30
Others..........................	705.0	1083.8	2.84	2.66	2.00	2.89

the days lost per case was greater among the females for each principle disease group except diseases of the nervous system, non-industrial accidents, and diseases of the genito-urinary system. The comparatively short duration of disease of the genito-urinary system among the females is accounted for by the large number of cases and brief duration of dysmenorrhea.

But what specific diseases and conditions were most prevalent among the rubber workers under consideration? The most frequent cause of disability among the males was "excessive colds" for which the case rate was 196 per 1,000. Though severe colds were more frequent among the females than among the males, colds were not the first cause of disability among the women employees. Tonsillitis with a rate of 239 cases per 1,000 was the most frequent cause of female inability to work. There were 388 cases of tonsillitis among 1,625 women, causing an absence of 6.3 days per case, and a day and a half of lost time per woman per year. Severe colds among the men inca-

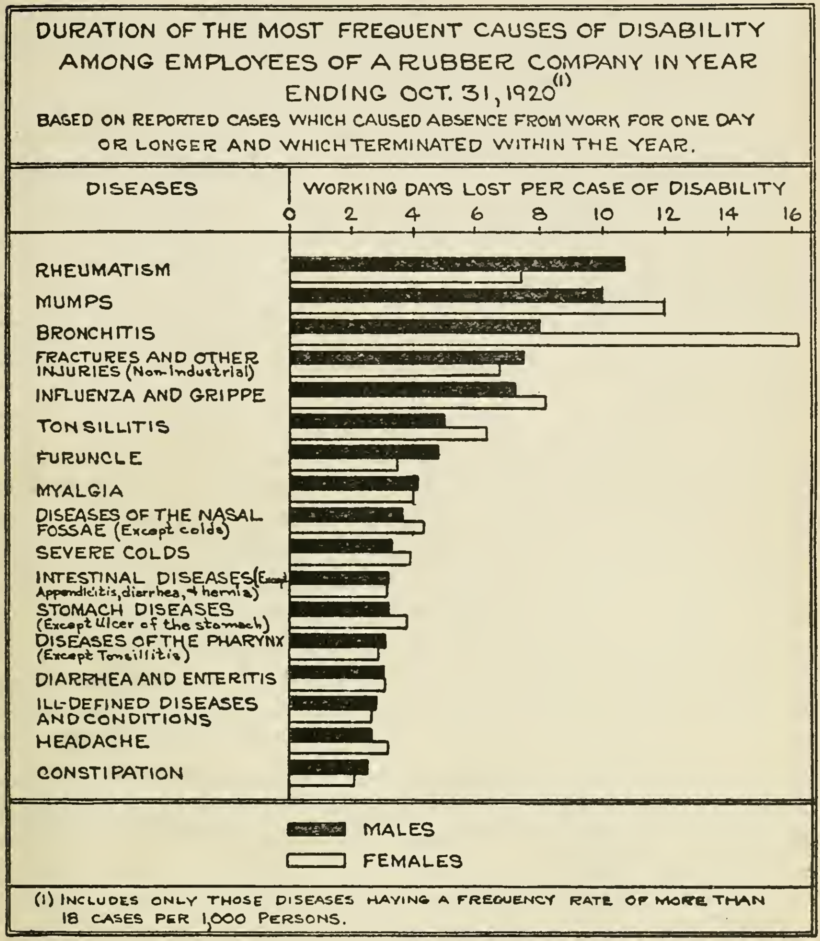

Fig. 2.

pacitated on the average for 3.3 working days, causing a loss of 0.7 of a day per man per year. Among the women hard colds caused an average disability of 3.9 working days per case and 0.9 of a working day per person per year. Influenza and grippe ranked second in point of frequency among the males, and third among the females. Two thousand eight hundred and twenty-seven male cases averaged 7.2 working days lost, and 293 female cases, 8.2 working days lost. Dysmenorrhea was the fourth greatest cause of disability among the women, causing an absence of 2.6 working days per case.

Other interesting sex comparisons might be cited. Headache, for example, was only slightly more frequent among females than among males. The women were not attacked by bronchitis as frequently as were the men, and their rate for constipation was only one-third of the male rate. The female rate for rheumatism was less than the male rate, and the frequency of boils (furuncle) was only one-seventh of the male rate for this cause of incapacity for work. The women had neuralgia and neuritis more often than the men, and also diseases of the eyes; but men had more diseases of the circulatory system, possibly partly for the reason that a larger proportion were in the older ages. Other points will doubtless suggest themselves to those who desire to examine the tables in greater detail.

Attention is called to Figure 2 which shows the duration of the most frequent causes of disability among both male and female employees of the company.

These two tabulations are presented merely as samples of the material which is afforded in the records of industrial establishments. It is obvious that they are not so complete or so accurate as may be desired, but it is believed that they constitute a definite advance over the fragmentary data available from health departments. It is believed also that when the data are collected in a larger mass, for a longer period, and in greater detail for persons of different occupational status, race, sex, and age, they will afford the first considerable body of dependable material for the use of the statistician in the study of disease incidence as well as for the student of industrial hygiene in its broader aspects. Certainly the employer who desires to know definitely how he can improve most effectively the health of his workers will be aided not only by a more careful scrutiny of his own records when they are intelligently tabulated and analyzed, but by the accumulated experience of other plants.

MORTALITY RATES OF COLLEGE WOMEN

By Myra M. Hulst, *American Red Cross*

This investigation was begun at the suggestion of Dr. Louis I. Dublin, Statistician for the Metropolitan Life Insurance Company and Lecturer in Vital Statistics at Yale University, and has been carried out with helpful suggestions from him. A grant made by the American Association for the Advancement of Science has defrayed the expenses involved.

The gathering of the data for this study was begun in 1918, and at that time the intention was to study the mortality rates among the graduates of the eight largest woman's colleges* used in the report on college women's occupations made by Miss Mary Van Kleeck of the Russell Sage Foundation. It was found impossible to do this because of the enormous amount of labor involved. The graduates from Vassar, Wellesley, and Smith, which included a large proportion of the alumnae of the eight colleges, were finally chosen for study. Of the 22,692 women graduating since the founding of the eight colleges, through the class of 1914, there were 15,561 graduates from Vassar, Wellesley, and Smith, or 68.6 per cent of all the alumnae from these eight colleges.

Investigations of the mortality rates for special groups present many obstacles, chief of which is the great difficulty of following a sufficient number of persons throughout their lives. College women present fewer difficulties than would be encountered in most other groups. Records taken in their college days of the dates of birth are available, as are also the facts of death as they occur among the graduates and are recorded by alumnae associations and the college registrars.

There is, no doubt, much in common in the habits, modes of life, and general circumstances of these women, which makes them a homogeneous group for study. They start out in life from college at approximately the same age. The median age at graduation for this whole group was twenty-two years. The environmental conditions, both before and after graduation, would be, on the whole, admittedly more favorable than the average for the community at large. The large number of old American family names among them would lead one to conclude that most of them are women of native stock.

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* These included Barnard, Bryn Mawr, Mt. Holyoke, Radcliffe, Smith, Vassar, Wellesley, and Wells.

In the gathering of the necessary data for study, three facts were noted concerning each graduate: the year of graduation, the date of birth, and whether deceased or not; and if dead, the date of death. To this end the Collegiate Alumnae Association generously lent the records which they had collected in the earlier census of the occupations of college women. These records, however, were not complete for a considerable proportion of graduates, and it was necessary to supplement their files. This was done through the coöperation of the registrars of the colleges, and from alumnae catalogues and bulletins. Every effort was made to complete the records for the graduates, both living and dead, of the three colleges. The material was altogether in very excellent condition at Smith and Vassar Colleges; but in a few cases where certain items, such as the date of death, were not available, they were obtained by writing to friends or relatives of the deceased. A fire had destroyed part of the Wellesley records, so that they were somewhat less complete than the records of the other colleges. By correspondence with alumnae some missing dates were found, making less than 3.5 per cent of the total dates of birth as unknown in the case of Wellesley, which was too small a percentage to affect the final results. In a few instances, where no date of birth was known, the person was considered 22 years of age at graduation, this being the median age at graduation for all colleges. Tabulations were made on the exposure year basis, beginning with the first of July and running through to June 30. This was necessitated by the fact that the date of graduation is in the middle of the calendar year at all schools.

The facts were then tabulated separately for each class of graduates. Every individual was followed up to July, 1915, and was dropped out of the count only in the event of her death. It was impracticable to carry the study further than 1915 because of the danger that some of the deaths subsequent to this date would not be known to the college authorities. The number of years of life exposed were in this way obtained for each age. They were later grouped by five and ten year periods, first for each class, and then for all classes of each college. These were found to accumulate to 66,885 years between the ages of 20 and 69 years for Vassar, 72,415 years between the ages of 20 and 59 for Smith, and 65,253 years between the ages of 20 and 64 for Wellesley. This gave a total of 204,553 years of life exposed for the whole study. The number of deaths was likewise obtained for each one of the age periods. Table 1 shows for each college, Vassar, Wellesley, and Smith, the exposure, the number of deaths, and the death rates per 1,000 for each of the age periods:

TABLE 1A

DEATH-RATES PER 1,000 EXPOSED. VASSAR COLLEGE ALUMNAE 1867–1914

Age period	Years of life exposed	Deaths	Death-rate per 1,000 exposed
20 to 69—total..........	66,885.08	278	4.16
20 to 24....................	12,357.58	17	1.38
25 to 34....................	30,436.10	99	3.25
35 to 44....................	14,282.64	65	4.55
45 to 54....................	6,672.50	57	8.54
55 to 64....................	2,879.25	34	11.81
65 to 69....................	257.01	6	23.34

TABLE 1B

DEATH-RATES PER 1,000 EXPOSED. SMITH COLLEGE ALUMNAE 1879–1914

Age period	Years of life exposed	Deaths	Death-rate per 1,000 exposed
20 to 59—total..........	72,414.68	185	2.55
20 to 24....................	14,439.92	18	1.25
25 to 34....................	38,723.02	100	2.58
35 to 44....................	15,351.00	50	3.26
45 to 54....................	3,673.65	13	3.54
55 to 59....................	227.09	4	17.61

TABLE 1C

DEATH-RATES PER 1,000 EXPOSED. WELLESLEY COLLEGE ALUMNAE 1879–1914

Age period	Years of life exposed	Deaths	Death-rate per 1,000 exposed
20 to 64—total..........	65,252.75	205	3.14
20 to 24....................	11,836.09	18	1.52
25 to 34....................	32,859.25	84	2.56
35 to 44....................	15,605.99	73	4.68
45 to 54....................	4,622.33	25	5.41
55 to 64....................	329.09	5	15.19

The specific death-rates for the graduates of Vassar College present a much more consistent picture of mortality than those for either Wellesley or Smith. The rates increase regularly with advancing age and, for the most part, are in close agreement with specific death-rates available for similar groups previously studied. As shown in Table 2, the findings for the graduates of Vassar College are in close agreement with those for New York City school teachers and for women insured in the Ordinary Department of the Metropolitan Life Insurance Company. The rates are very much lower than for women in the Registration Area of the United States; but these differences are to be expected in view of the more favorable social and economic condition of these Vassar graduates, their greater knowledge and very probable practice of personal hygiene, their less arduous and protected occupations, and their relative freedom from the hazards incident to childbearing.

The death-rates for Wellesley Alumnae also show an increase at each succeeding age period. The rise in the death-rate with advancing age does not take place so rapidly or so consistently as in the case of Vassar's mortality. At the age period 25 to 34 years, the rate for Wellesley is slightly lower than that for Vassar, and at the age 45 to 54 years, Vassar presents a death-rate considerably higher than that of Wellesley. At the highest age period represented by Wellesley, 55 to 64 years, the rate shows an excess over that of Vassar; but the years of life exposed at this age period are too few to be of particular significance.

The facts for the alumnae of Smith College are very surprising indeed. The death-rates are lower than those for Vassar or Wellesley, but the difference is most marked in the age period 45 to 54, where the rate, 3.54, is less than one-half that for Vassar. In view of these findings, additional effort was made to certify to the accuracy of the data. Every possible channel was employed to discover unrecorded deaths. Letters were sent to each of the class secretaries from 1879 to 1895, which included the graduates who would be in the age period in which the extraordinary low death-rate occurred. Replies were received from each one of these secretaries and the record of only one additional death was obtained. There was no deceased member in the class of 1883 out of a total of 49 graduates. We quote here the reply received from the secretary of this unique class: "None of the 49 graduates of the class of 1883 has died—a record unequalled so far as I know in any class of men or women." This fact was further corroborated by emphatic statements from other members of the class. Another secretary certified to the record of only one deceased member in her class. Others confirmed our findings to the letter. In spite of the exceptional character of these figures for Smith College, we present them herewith with the assurance that they represent the truth as far as this college is concerned. It must be realized that the number of years of life exposed in the age period 45 to 54 is comparatively small. The death-rate is, therefore, subject to the error arising from small numbers. The number of years of life exposed for Smith College at this age period is only half that of Vassar. The Vassar experience started with the first class graduating in 1867, and for Smith and Wellesley Colleges, the first alumnae graduated in 1879, which gives a much larger proportion of graduates for Vassar who have reached the higher age periods than for either of the other two colleges studied. But in view of the consistently lower death-rate in Smith for every age period, there is suggested the possibility that the differences in the figures represent real differences in the vitality of the graduates of the three colleges studied. Table 2 presents a comparison of the specific death-rates for the three colleges and for the other groups of women for which data are available:

TABLE 2

DEATH-RATES PER 1,000 WOMEN, VASSAR, WELLESLEY, AND SMITH ALUMNAE. METROPOLITAN LIFE INSURANCE COMPANY—ORDINARY DEPARTMENT EXPERIENCE—1914-1916. NEW YORK CITY TEACHERS, 1907-1914, AND REGISTRATION AREA, 1910-1915

Age period	Vassar Alumnae	Wellesley Alumnae	Smith Alumnae	Ordinary Ins. Experience, M. L. I. Co.	N. Y. City Teachers	U. S. Reg. W. A. Area
20 to 24......	1.38	1.52	1.25	....	1.48	4.96
25 to 34......	3.25	2.56	2.58	3.02	2.98	6.10
35 to 44......	4.55	4.68	3.26	4.83	4.32	8.03
45 to 54......	8.54	5.41	3.54	9.16	9.84	12.58
55 to 64......	11.81	15.19	...	20.04	16.67	24.48

In this table special interest attaches to the figures for New York City Teachers, taken from an investigation by Mr. George Buck on Teachers' Pensions. The death-rates for all periods are found to be very much like those for college graduates. They are more in accordance with the rates for Vassar Alumnae than for either of the other two colleges; the only appreciable difference between these two groups being at the age period of 55 to 64 years. In the case of Wellesley the difference begins at a lower age period, 45 to 54 years; at the next age period, 55 to 64, the rate for Wellesley is but slightly less than that for New York teachers.

The study made of school teachers' mortality is the most comparable to that of college women of any special mortality experience which has been computed. The age distribution of school teachers and college women is much the same, the majority of them being in the period of 20 to 34 years of age. Teaching is the occupation of a large proportion of college women. In the study of college women's occupations, it was found that 58 per cent of all graduates prior to war conditions had been engaged in teaching. It is to be expected that we should find college women and school teachers agreeing in such low rates of mortality. This low rate of mortality is thus commented upon in the Pension Study of New York City Employees, Report on the Pension Fund of the City of New York, Commission on Pension, 1916. Part II, p. 102: "The death-rate as a whole is lower among women teachers than any other class except men teachers and members of the College of the City of New York Retirement Fund. The death-rates for teachers were found to be the lowest existing in New York City service."

Table 3 presents for each age period from 20 to 64 the death-rates of college women as computed from the combined mortality of Vassar, Wellesley, and Smith graduates. The mortality experience of these women shows a very low rate for each age period in comparison with the general female population of the United States.

TABLE 3

DEATH-RATES PER 1,000 EXPOSED OF COLLEGE WOMEN. RATES FOR VASSAR, WELLESLEY, AND SMITH COLLEGES COMBINED

Age period	Years of life exposed	Deaths	Death-rate per 1,000 exposed
20 to 64—total..........	204,295.50	662	3.24
20 to 24.....................	38,633.59	53	1.37
25 to 34.....................	102,018.37	283	2.77
35 to 44.....................	45,239.63	188	4.15
45 to 54.....................	14,968.48	95	6.35
55 to 64.....................	3,435.43	43	12.52

The crude death-rate for each college studied is also very low. In the case of Vassar, which had the greatest number of alumnae in the higher age periods, the ages 20 to 69 are included, and give a crude rate for these ages of 4.16 per 1,000 exposed. Smith, which has too few alumnae above the ages 20 to 59 to include any higher ages, gives a crude rate of 2.55; and Wellesley for the period 20 to 64 years has a rate of 3.14 per 1,000.

As we do not know what the causes of death for these college women are, we can only conjecture what some of the factors may be which result in such a favorable mortality. In the first place, they evidently were a highly selected group of women, with excellent health, to have been able to pass through four years of college. During these years they enjoyed an exceptionally good environment, and opportunities were afforded them for physical exercise, both through outdoor sports and gymnastics which are usually required of students during part of their college course. Physical and medical examinations given to all students result in the discovery of defects which can be remedied. Even in the earliest years of Vassar we find that very complete physical records of the students were taken. It is to be expected, too, that they would have learned under these unusually healthful conditions of life the proper adjustment to work, and to rest and amusement, which are considered important elements in the prolongation of life.

It is a generally accepted fact that classes well enough off economically to be able to provide themselves with adequate medical care and a good, healthful, sanitary environment can prolong their lives beyond those less fortunate. College women belong to a class that is fairly well-off economically. Of the women reporting their earnings in the *Census of College Women* referred to above, the median income in 1914 was $1,013. This was high in comparison with the earnings of women of the industrial classes for that year. Professor Irving Fisher, of Yale University, has emphasized the effect of economic conditions in these words: "That a well-to-do class, properly fed and clothed, and with opportunity for leisure, will be less susceptible to disease than a poverty-stricken class, ill-fed and over-worked, has been repeatedly shown by statistics."

College women are not so much exposed to the causes of death incidental to child-bearing as are other women. The census of Miss Van Kleeck shows that in 1915 there was married an average of about 50 per cent of the classes graduating prior to 1900. For Vassar, the total proportion of those who had married in all classes through the year 1915 was 45.1 per cent; 38.3 per cent for Wellesley, and 44.5 per cent for Smith. These figures show that less than one-half of college graduates are exposed to the hazards of childbirth, which is a much smaller proportion than among other women. The families borne by college graduates are also exceptionally small. It was found that they averaged but 2.1 children per family for all married graduates; and among married graduates in classes prior to 1890, whose families would be completed, the average number of children is also low, being 2.8. Between the ages of 15 and 45 years, statistics show that more deaths among women are caused by hazards of child-bearing than by any other cause except tuberculosis. Many of these deaths are due to inadequate care or lack of proper medical attention—a condition which would rarely be found among college women.

Our results, which show a remarkably low mortality rate among college women, are, therefore, not surprising. The results obtained indicate how much saving in mortality can be accomplished through extending to other women of the country the advantages which these college women enjoy. The conditions among them may be set up as a standard for the rest—a goal to be attained. The effect on the death-rate in the country at large would be tremendous if only half the difference were wiped out.

RAPID METHODS OF APPROXIMATING TO TERMS IN A BINOMIAL EXPANSION

By George F. McEwen, *Scripps Institution for Biological Research, University of California*

CONTENTS

1. Introduction. 2. The Symmetrical Binomial. 3. The Asymmetrical or Skew Binomial. 4. References Cited.

1. INTRODUCTION

The labor of computing terms or sums of terms in a binomial expansion can be greatly reduced by the use of certain continuous functions approximating to the values desired. Although these functions are treated in many texts and papers, the simple transformations and substitutions required to obtain formulae directly applicable to computations pertaining to binomial series are in general left for the student to make.

This paper brings together the most suitable of these functions and illustrates their use in order to meet the needs of investigators wishing to obtain numerical results as readily as possible.

2. THE SYMMETRICAL BINOMIAL

The xth term counted from the middle one in the expansion of the symmetrical binomial*

$$\left(\frac{1}{2}+\frac{1}{2}\right)^n=\left(\frac{1}{2}\right)^n+n\left(\frac{1}{2}\right)^n+\frac{n(n-1)}{1\cdot 2}\left(\frac{1}{2}\right)^n+\frac{n(n-1)(n-2)}{1\cdot 2\cdot 3}\left(\frac{1}{2}\right)^n+\ \ldots \tag{1}$$

where the number of the term is

$$r=1,\ 2,\ 3,\ 4\ \ldots \tag{2}$$

is approximately given by the familiar exponential expression (Yule, 1911, p. 300; Merriman and Woodward, 1900, pp. 482–483)

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* When n is even, there are an odd number $(n+1)$ of terms, and corresponding to the middle term which is also the maximum, x has the value zero.

When n is odd, there are an even number $(n+1)$ of terms, the two central ones are equal, and the corresponding values of x are, respectively $+\frac{1}{2}$ and $-\frac{1}{2}$.

In both cases

$$r=\frac{n}{2}+1+x$$

or

$$x=r-\frac{n+1}{2}-\frac{1}{2}.$$

$$y = \frac{1}{\sqrt{2\pi}\sigma} e^{-\frac{x^2}{2\sigma^2}} = \frac{.399}{\sigma} e^{-\frac{x^2}{2\sigma^2}} \tag{3}$$

where

$$\sigma = \text{the standard deviation} = \tfrac{1}{2}\sqrt{n} \tag{4}$$

and

$$e = 2.7183, \text{ the Naperian base of logarithms.}$$

With the aid of a tabulation of this exponential function (Davenport, 1899, p. 21 and 54; Fowle, 1914, pp. 48–54) its value can be quickly found when n and x are given. The difference between this function and the corresponding term of the binomial series decreases as n increases, but the approximation is close even when n is as small as 8, as shown by Table I.

TABLE I

VALUES OF TERMS IN THE BINOMIAL EXPANSION COMPARED WITH THE CORRESPONDING EXPONENTIAL FUNCTION

r	x	y	Terms of the expansion $(\frac{1}{2}+\frac{1}{2})^8$
1	−4	.0052	.0039
2	−3	.0313	.0313
3	−2	.1038	.1092
4	−1	.2198	.2184
5	−0	.2822	.2730

To compute the value of y, substitute 8 for n in the general expression

$$y = \frac{.798}{\sqrt{n}} e^{-\frac{2X^2}{n}} \tag{5}$$

obtained from equations (3) and (4), thus obtaining

$$y = .2822\, e^{-\frac{x^2}{4}}. \tag{6}$$

To find y for a given value of x (x is negative for terms to the left of the middle one), say, $x = -2$, substitute -2 for x in equation (6) and find the value of $e^{-\frac{2^2}{4}} = e^{-1} = \frac{1}{e}$ from table 18 (Fowle, 1914, p. 49). Thus

$$y = (.2822)(.3679) = .1038. \tag{7}$$

To use Davenport's (1899) table (p. 54), find from equation (4)

$$\sigma = \tfrac{1}{2}\sqrt{8} = \sqrt{2}. \tag{8}$$

Thus for $x = -2$

$$\frac{x}{\sigma} = -\frac{2}{\sqrt{2}} = -\sqrt{2} = -1.414 \tag{9}$$

$$\frac{y}{y_0} = e^{-\frac{x^2}{2\sigma^2}} = .3753 - .14(.3753 - .3246) = .368 \tag{10}$$

and as before

$$y = (.2822)(.368) = .1038. \tag{11}$$

If n equals the odd number, 9, substitution in equation (5) gives

$$y = .266e^{-\frac{2}{9}x^2}, \tag{13}$$

from which the entries in column 3 of Table II were computed.

TABLE II

VALUES OF TERMS IN THE BINOMIAL EXPANSION COMPARED WITH THE CORRESPONDING EXPONENTIAL FUNCTION

r	x	y	Terms of the expansion $(\frac{1}{2}+\frac{1}{2})^9$
1	−4.5	0.0030	0.0020
2	−3.5	0.0175	0.0176
3	−2.5	0.0663	0.0704
4	−1.5	0.1622	0.1640
5	−.5	0.2516	0.2460
6	.5	0.2516	0.2460

A continuous function approximating to the terms of a series is especially useful in computing the sum of a given number of terms, since another continuous function approximating to this sum results from integration. Thus the sum of any number (x) of terms counted from the middle or zero'th term of the binomial expansion is given approximately by the integral

$$\int_0^x y\,dx = \frac{1}{\sqrt{2\pi}\sigma}\int_0^x e^{-\frac{x^2}{2\sigma^2}}dx = \sqrt{\frac{2}{\pi n}}\int_0^x e^{-\frac{2x^2}{n}}dx \tag{14}$$

where y is given by equation (3), or (5).

Substitution of a new variable $t=x\sqrt{\frac{2}{n}}$ in equation (14) gives the well-known "probability integral"*

$$\int_o^x y dx = \frac{1}{\sqrt{\pi}}\int_o^t e^{-t^2}dt \tag{15}$$

whose values are tabulated in various books on statistics and least squares (for example, Yule, 1911, p. 306; Davenport, 1899, p. 55; Broggi, 1911, pp. 354–356; Fowle, 1914, p. 56; Merriman, 1903, p. 220).

When n is even, if x has the value $\pm\frac{1}{2}$, the integral (14) or (15) gives $\frac{1}{2}$ of the middle term, for $x=\pm(1+\frac{1}{2})$ the integral gives the value of $\frac{1}{2}$ the middle term, plus the next term, and so on.

When n is odd, if x has the value ± 1, the integral (14) or (15) gives one of the two central terms, for $x=\pm 2$ the integral gives one of the two central terms plus that of an adjacent term, and so on.

To find the sum of the first r terms [counting the 1st term as one, see equations (1) and (2)], find the sum from the middle term to, but not including the r th term, and subtract the result from $\frac{1}{2}$, which is the sum of the first $\frac{n+1}{2}$ terms. That is, for odd or even values of n

$$x=\left(r-\frac{n+1}{2}\right) \tag{16}$$

and the sum of first r terms is

$$\tfrac{1}{2}\left\{1-\frac{2}{\sqrt{\pi}}\int_o^t e^{-t^2}dt\right\} \tag{17}$$

where

$$t=x\sqrt{\frac{2}{n}}=-\frac{n-2r+1}{\sqrt{2n}}. \tag{18}$$

Table III gives the sum of portions of several binomial expansions,

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* To determine the probability of obtaining any proportion of an equal number of each of two different things, put

$$\theta=\frac{x}{n} \text{ or } x=n\theta$$

where θ is the difference between the true proportion, $\frac{1}{2}$ and the observed proportion, then

$$t=\theta n\sqrt{\frac{2}{n}}=\theta\sqrt{2n}.$$

This agrees with the result derived by Hatai (1910) from the theorem of Bayes for determining the probability that the true proportion differs by θ from the observed value.

taken from a biological paper (Sumner, 1910, p. 330), and the approximation to these sums given by the "probability integral."

TABLE III

SUMS OF TERMS IN CERTAIN BINOMIAL EXPANSIONS AND CORRESPONDING VALUES OBTAINED FROM THE PROBABILITY INTEGRAL

n	r	$n-2r+1$	$\sqrt{2n}$	t equals $\frac{n-2r+1}{\sqrt{2n}}$	$\frac{2}{\sqrt{\pi}}\int_0^t e^{-t^2}dt$	$1-\frac{2}{\sqrt{\pi}}\int_0^t e^{-t^2}dt$	$\frac{1}{2}\left[1-\frac{2}{\sqrt{\pi}}\int_0^t e^{-t^2}dt\right]$	Sum of terms of binomial
10	2	7	4.472	1.566	.9732	.0268	.0134	.0193
11	1	10	4.691	2.133	.9974	.0026	.0013	.0005*
11	3	6	4.691	1.280	.9297	.0703	.0351	.0327
11	4	4	4.691	.853	.7725	.2275	.1137	.1111
18	6	7	6.000	1.167	.9011	.0989	.0494	.0588
19	4	12	6.160	1.948	.9941	.0059	.0029	.0022
19	6	8	6.160	1.298	.9336	.0664	.0332	.0318
32	7	19	8.000	2.375	.9992	.0008	.0004	.00041
56	14	29	10.580	2.745	.9999	.0001	.00005	.00005

* The approximation is closer as r increases, and for computing one or two terms the binomial series itself should be used, instead of the integral.

To illustrate the process, determine the sum of the first 7 terms in the expansion

$$\left(\frac{1}{2}+\frac{1}{2}\right)^{32}=\left(\frac{1}{2}\right)^{32}+32\left(\frac{1}{2}\right)^{32}+\frac{32\cdot 31}{1\cdot 2}\left(\frac{1}{2}\right)^{32}+\ \dots$$

$$r=1,\ 2,\ 3,\ \dots \qquad (19)$$

Here,

$$n=32,\ r=7,\ n-2r+1=19 \qquad (20)$$

and $t=\frac{19}{\sqrt{2\cdot 32}}=2.375$ (Table III, line 8). The corresponding value of the integral $\frac{2}{\sqrt{\pi}}\int_0^t e^{-t^2}dt$ (Merriman, 1903, p. 220), is .9992, and $\frac{1}{2}(1-.9992)=.0004$ the approximate value, which agrees well with .00041, the sum of the first 7 terms of the series (equation 19).

To use Table IV (Davenport, 1899, p. 55) the above expression for t must be replaced by

$$\frac{x}{\sigma}=\frac{\frac{n+1}{2}-r}{\frac{1}{2}\sqrt{n}}=\frac{n-2r+1}{\sqrt{n}},$$

and the tabular entry must be subtracted from $\frac{1}{2}$. If $n=32$, and $r=7$,

$$\frac{x}{\sigma}=\frac{32-14+1}{\sqrt{32}}=\frac{19}{\sqrt{32}}=3.360$$

and the corresponding tabular entry is .4996. The approximation to the sum is therefore $.5000-.4996=.0004$.

3. THE ASYMMETRICAL OR SKEW BINOMIAL

A function bearing the same relation to the skew binomial

$$\left.\begin{array}{llll}(p+q)^n=p^n+np^{n-1}q+\frac{n(n-1)}{1\cdot 2}p^{n-2}q^2+ & \ldots \\ r=1, \qquad 2, \qquad\qquad 3, & \ldots \\ p\neq q & \end{array}\right\} \qquad (21)$$

as the normal probability function bears to the symmetrical binomial was first found by E. L. Deforest (1882–3). In a review of Deforest's researches, Shinkishi Hatai (1910) presents a derivation of Deforest's (1882–3) formula

$$y=\frac{1}{k\sqrt{2\pi b}}\left(1+\frac{x}{ab}\right)^{a^2b-1}e^{-ax}. \qquad (22)$$

Where y is the approximate value of the xth term in the binomial series, the *mean* term $r=(nq+1)$ being the origin,

$$\left.\begin{array}{l}k=1+\frac{1}{12a^2b}+\frac{1}{288(a^2b)^2}+\ \ldots \\ a=\frac{2\mu_2}{\mu_3},\ b=\mu_2\end{array}\right\} \qquad (23)$$

μ_2 and μ_3 are respectively the second and third moments about the mean. These moments* of the binomial series are (Pearson, 1906–7,

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* By definition, the second moment $\mu_2=\frac{\Sigma f\cdot x^2}{N}$, where f is the frequency of a deviation x, and $N=\Sigma f=$ the sum of all the frequencies. If the interval between successive terms equals L, instead of unity, as assumed in the preceeding pages,

$$\mu_2=\frac{\Sigma f\cdot x^2\cdot L^2}{N},$$

since the deviation is xL. For a binomial series, the corresponding standard deviation becomes

$$\sigma=\sqrt{\mu_2}=\left\{\sqrt{\frac{\Sigma f\cdot x^2}{N}}\right\}L=\sqrt{npq}L.$$

If the total range, nL is denoted by R, the standard deviation becomes

$$\sigma=\left(\sqrt{npq}\right)\frac{R}{N}=\left(\sqrt{\frac{pq}{n}}\right)R.$$

p. 172; Greenwood, 1913, p. 71)

$$\left.\begin{aligned}\mu_2&=npq\\ \mu_3&=npq(p-q)\end{aligned}\right\}\qquad(24)$$

To illustrate the use of Deforest's rule, compute the rth term of the expansion $(.9+.1)^{20}$. By definition

$$p=.9,\ q=.1,\ n=20,\ 20\times.1+1=3$$

mean term or origin,

$$\mu_2=(20)(.9)(.1)=1.8$$

$$\mu_3=(20)(.9)(.1)(.9-.1)=1.44$$

$$a=\frac{2\times1.8}{1.44}=2.5,\ b=1.8,\ a^2b=11.25$$

$$k=1+\frac{1}{(12)(2.5)^2(1.8)}+\frac{1}{(288)[(2.5)^2(1.8)]^2}=1.0076.$$

Therefore

$$y=.295\left(1+\frac{2}{9}x\right)^{10.25}e^{-2.5x}\qquad(25)$$

where $x=(r-\text{ mean term})=r-3$.
To obtain the third term put $x=0$, then $y=\quad .295$.

To obtain the 6th term, put $x=3$, then

$$\begin{aligned}\log .295&=9.46982-10\\ 10.25\log\left(\frac{5}{3}\right)=(10.25)(.221858)&=2.27404\\ -7.5\log e=(-7.5)(.43429)&=-3.25717\\ \hline \log y&=8.48669-10\\ y&=.03067.\end{aligned}$$

As shown by Hatai (1910), Deforest's formula is equivalent to Pearson's Type III curve whose equation (referred to the mode as origin) is (Pearson 1914, p. xvl)

$$y=y_0e^{-\nu x}\left(1+\frac{\nu x}{m}\right)^m.\qquad(26)$$

In computing terms of a binomial expansion by means of equation (26), the constants have the values (Pearson, 1906–7)

$$m=\frac{4}{npq-\frac{4}{n}}-1,\ \nu=\frac{2}{p-q}$$

$$y_0=\frac{\nu m^m e^{-m}}{\overline{\lvert m+1}}.$$

But a more convenient form

$$y=y_0e^{-P_1}\frac{x}{a_1}\left(1+\frac{x}{a_1}\right)^{P_1} \tag{27}$$

for numerical work is given by Pearson (1914, pp. xlv and 37). These two forms will be equivalent if $p_1=m$ and $a_1=\frac{m}{\nu}$. Substituting the values of m and ν gives

$$P_1=\frac{4}{\frac{1}{\sigma^2}-\frac{4}{n}}-1=\frac{4\sigma^2(n+1)-n}{n-4\sigma^2}$$

and

$$a_1=\frac{\mathrm{P}_1(\mathrm{p}-\mathrm{q})}{2}$$

where $\sigma^2=npq$. In formula (27) the origin is at the mode, hence $x=r-$mode.

But for Pearson's Type III curve the relation of the mode to mean is (Elderton, 1906, p. 65)

$$\text{Mode}=\text{mean}-\tfrac{1}{2}\frac{\mu_3}{\mu_2}$$

which reduces to

$\text{Mode}=nq+1-\frac{p-q}{2}$ for the binomial series. Therefore in formula (27)

$$x=r-nq-1+\frac{p-q}{2}. \tag{28}$$

Also the simpler expression

$$\frac{1}{\sqrt{2\pi}\sigma}=\frac{.399}{\sigma}=\frac{1}{\sqrt{2\pi npq}}$$

can be used for y_0 (Merriman and Woodward, 1900, 482). Table IV. gives the terms of the expansion of $(.9+.1)^{20}$ computed from the series, and from Pearson's Type III curve.

TABLE IV

TERMS OF THE EXPANSION $(.9+.1)^{20}$ AND THE CORRESPONDING VALUES OF PEARSON'S TYPE III FUNCTIONS

r	x	$\frac{x}{a_1}=X$	$\log_{10}\frac{(1+X)}{e^x}$	$\log_{10} y$	y	Value of terms, computed from the expansion
1	—1.6	—.390	.046	$\bar{1}.001$	.1002	.122
2	—0.6	—.146	.0052	$\bar{1}.420$	.263	.270
3	0	0	0	$\bar{1}.473$	.297	.285
4	1.4	.342	.020	$\bar{1}.268$	.185	.190
5	2.4	.585	.052	$\bar{2}.939$	.087	.090
6	3.4	.830	.098	$\bar{2}.466$	.029	.032
7	4.4	1.073	.149	$\bar{3}.944$	.009	.009
8	5.4	1.318	.208	$\bar{3}.340$	.002	.002
9	6.4	1.560	.269	$\bar{4}.713$	.0005	.0004
10	7.4	1.805	.336	$\bar{4}.025$	.0002	.0001

To illustrate the use of Pearson's formula (equ. 27) compute y when $r=5$. Then $n=20$, $p=.9$, $q=.1$,

$$\sigma^2=20\times.9\times.1=1.8,\ \sigma=1.342$$

$$4\sigma^2=7.2$$

$$P_1=\frac{7.2\times21-20}{20-7.2}=\frac{131.2}{12.8}=10.25,\ a_1=\frac{10.25(.9-.1)}{2}=4.1$$

and

$$y_0=\frac{.399}{1.342}=.2973 \text{ and } X=\frac{x}{a_1}.$$

To find $\log_{10}y$, subtract P_1 times the value of

$$\{\log_{10}(1+X)-X\operatorname{Log}_{10}e\}$$

found in Pearsons' Table XXVI (1914, p. 37), from $\log_{10}y_0$.

For example, if $r=5$, $x=5-3+.4=2.4$, $X=\frac{2.4}{4.1}=.585$

$$\{\log_{10}(1+X)-X\operatorname{Log}_{10}e\}=.052$$

$(10.25)\ (.052)=.534$

$$\log y_0=\log\ .2973=\bar{1}.473$$

$$\log y=\bar{2}.939$$

$$y=.087$$

The sum of any number $(r-s)$ of terms measured from the mean is

$$\int_o^x y dx = y_0 \int_o^x e^{-p_1 \frac{x}{a_1}} \left(1+\frac{x}{a_1}\right)^{p_1} dx \tag{29}$$

where $x = r - s + \frac{p-q}{2}$;

but tables of this integral are not available.

Edgeworth's (1906) theory of skew variation based on an extension of the methods by which the norman law was derived yields much more convenient formulae than Pearson's more general theory. Tolley (1916) concluded that Edgeworth's (1906) approximate rule (see equation (30)) would suffice for climatic data, and has published convenient tables for its application (Tolley 1916, pp. 640–1).

The total area of the generalized curve between the abscissa x_1 and x_2 is

$$A = \int_{x_1}^{x_2} \left(\frac{1}{\sigma\sqrt{2\pi}}\right) e^{-\frac{x^2}{2\sigma^2}} dx - \left[\frac{1}{\sqrt{2\pi}} e^{-\frac{x^2}{2\sigma^2}} \left(\frac{k}{1\cdot 2\cdot 3}\right)\left(\frac{x^2}{\sigma^2}-1\right)\right]_{x=x_1}^{x=x_2} \tag{30}$$

(Tolley, 1916, p. 638), where

σ = standard deviation,

x = distance (abscissa) from mean, x_m

μ_3 = third moment about the mean

N = total number of observations,

$k = \frac{\mu_3}{\sigma_3}$.

For the binomial series (equation 21) on page 611

$$\sigma = npq,\ \mu_2 = npq\ (p-q),\ k = \frac{p-q}{\sqrt{npq}}.$$

If $y = \frac{x}{\sqrt{2\sigma}}$, equation (30) becomes

$$A = \int_{y_1}^{y_2} \frac{1}{\sqrt{\pi}} e^{-t^2} dt - \left[\frac{1}{\sqrt{2\pi}} e^{-t^2} (2t^2-1)\frac{k}{6}\right]_{y=y_1}^{y=y_2}. \tag{31}$$

If y_2 equals ∞, $A = A_r$, area to the right of y_1.

If y_1 equals $-\infty$, $A = A_L$, area to the left of y_2.

That is,

$$A_r = \frac{1}{\sqrt{\pi}}\int_{y_1}^{\infty} e^{-t^2}dt + \left[\frac{1}{\sqrt{2\pi}} e^{-y_1^2}(2y_1^2-1)\frac{k}{6}\right] \tag{32}$$

$$A_L = \frac{1}{\sqrt{\pi}}\int_{-\infty}^{y_2} e^{-t^2}dt - \left[\frac{1}{2\pi} e^{-y_2^2}(2^{y_2^2}-1)\frac{k}{6}\right] \tag{33}$$

but

$$\frac{1}{\sqrt{\pi}}\int_{y_1}^{\infty} e^{-t^2}dt = \tfrac{1}{2}\left[1 - \frac{2}{\sqrt{\pi}}\int_0^{y_1} e^{-t^2}dt\right],\ y_1 \overset{=}{>} 0 \tag{34}$$

$$\frac{1}{\sqrt{\pi}}\int_{-\infty}^{y_2} e^{-t^2}dt = \tfrac{1}{2}\left[1 + \frac{2}{\sqrt{\pi}}\int_0^{y_2} e^{-t^2}dt\right],\ y_2 \overset{=}{>} 0 \tag{35}$$

$$\frac{1}{\sqrt{\pi}}\int_{y_1}^{\infty} e^{-t^2}dt = \tfrac{1}{2}\left[1 + \frac{2}{\sqrt{\pi}}\int_0^{y_1} e^{-t^2}dt\right],\ y_1 \overset{=}{<} 0 \tag{36}$$

$$\frac{1}{\sqrt{\pi}}\int_{-\infty}^{y_2} e^{-t^2}dt = \tfrac{1}{2}\left[1 - \frac{2}{\sqrt{\pi}}\int_0^{y_2} e^{-t^2}dt\right],\ y_2 \overset{=}{<} 0 \tag{37}$$

and the "probability integrals" in the second members are given in various tables, *e. g.*, Broggi (1911, p. 354), Czuber (1914, p. 437), Fowle (1914, p. 56), Merriman (1903, p. 220) and Pearson (1914, pp. 9–10). The exponential e^{-y^2} has also been tabulated by various authors, *e. g.*, Fowle (1914, p. 48), or may be obtained from a table of the "probability integral" since

$$e^{-y^2} = \frac{\int_{y-\Delta y}^{y+\Delta y} e^{-t^2}dt}{2\Delta y} = \frac{\sqrt{\pi}}{2}\left\{\frac{\frac{2}{\sqrt{\pi}}\int_0^{y+\Delta y} e^{-t^2}dt - \frac{2}{\sqrt{\pi}}\int_0^{y-\Delta y} e^{-t^2}dt}{2\Delta y}\right\}. \tag{38}$$

For example suppose we wish any term or the sum of any number of terms of the series

$$\begin{array}{lcccccc} & (.9+.1)^{20} = & .122+ & .270+ & .285+ & .190+ & .090+.032 \\ r= & & 1, & 2, & 3, & 4, & 5, \quad 6, \\ & & & +.009+ & .002+ & .0004+ & .0001, \\ & & & 7, & 8, & 9, & 10. \end{array} \tag{39}$$

Then,

$$p = .9,\ q = .1,\ n = 20$$

$$\text{mean} = nq + 1 = 2.0 + 1 = 3.0$$

$$\sigma = \sqrt{(20)(.9)(.1)} = 1.342$$

$$k = \frac{.9 - .1}{1.342} = .596,\ \frac{k}{6} = .0993$$

$y = \dfrac{x}{\sqrt{2}\sigma} = .5268x$, and equations (33), (35), and (37) become

$$A_L = \tfrac{1}{2}\left[1 + \frac{2}{\sqrt{\pi}}\int_0^{y_2} e^{-t^2}dt\right] - .0396\, e^{-y_2^2}(2y_2^2 - 1), \tag{40}$$

for $x \geqq 0$, and

$$A_L = \tfrac{1}{2}\left[1 - \frac{2}{\sqrt{\pi}}\int_0^{y_2} e^{-t^2}dt\right] - .0396\, e^{-y_2^2}(2y_2^2 - 1), \tag{41}$$

for $x < 0$, where the absolute values of y are to be substituted.

Let $x = 0$, then $y_2 = 0$ and Equation (40) becomes

$$A_L = \tfrac{1}{2} + .0396 = .5396.$$

Let $x = 1.5$, then $y_2 = .7902$, $y_2^2 = .6244$, $e^{-y_2^2} = .5404$ and Equation (40) gives

$$\frac{1.7362}{2} - .0053 = .8628.$$

Let $x = -1.5$, then $y_2 = -.7902$ and equation (41) gives

$$\frac{1 - .7362}{2} - .0053 = .1266.$$

The table of values of A_L published by Tolley (1916, pp. 640–641) can be used to facilitate the work, as illustrated by the following computation of the values already obtained.

As before, k has the constant value .596 for all the terms of the series.

Suppose $x = 0$, then from the table

	Tabular entry, A_L,	k
	.53989,	.600,
	.52660,	.400,
Diff.	.01329	.200
Diff.	.00027	.004 = .600 − .596
	.53962 = Interpolated value of A_L.	

Suppose $x = 1.5$, then $\dfrac{x}{\sigma} = 1.117$ and from the table

Tabular entry, A_L value of $\dfrac{x}{\sigma}$

when $k=.6$	.85976	1.10
	.86829	1.15
Diff.	.00853	.05
Diff.	.00289	$.017=1.117-1.10$

$.86265=A_L$, when $k=6.00$ and $\frac{x}{\sigma}=1.117$

Diff. .00003 correction for reducing to $k=.596$.

.8627 Final interpolated value of A_L

Suppose $x=-1.5$, then $\frac{x}{\sigma}=-1.117$ and from the table

	Tabular entry, A_L	value of $\frac{x}{\sigma}$
when $k=0.600$		
	.13109	-1.10
	.11843	-1.15
Diff.	.01266	.05
Diff.	.0042	$.017=-1.10+1.117$

$.12687=A_L$ when $k=.600$ and $\frac{x}{\sigma}=1.117$

.00003 correction for reducing to $k=.596$

.1269 Final interpolated value of A_L.

To compare these results with the exact values given by the series, we must remember that x is counted from the mean term $np+1=3$, as origin and therefore in general (See equation 21), $r=3+x$. The first two terms plus ½ the mean term $.122+.270+\frac{.285}{2}=.5345$ corresponds to $x=0$, and agrees well with .5396 obtained from the formula. When $x=-1.5$ the sum is simply the first term, .122. The formula gives .127. When $x=1.5$, the sum is the first 4 terms $.122+.270+.285+.190=.867$. The formula gives .863.

In the case of an extremely asymmetrical binomial in which $\frac{q}{pn}$ is very small, the computation of the general term can be most readily made by means of Poisson's exponential expansion. (Pearson 1914, p. lxxvii and pp. 113–21.) The smaller the ratio $\frac{q}{pn}$, the more closely the terms of the binomial series

$$(p+q)^n=p^n+np^{n-1}q+\frac{n(n-1)}{1\cdot 2}p^{n-2}q^2+\cdots$$

approximate to those of the exponential series

$$e^{-m}\left(1+m+\frac{m^2}{1\cdot 2}+\frac{m^3}{1\cdot 2\cdot 3}+\cdots\right)$$

$r=$ 1, 2, 3, 4

where $m=nq$. The expression $e^{-m}\left(\frac{m^x}{x!}\right)$ for the $(x+1)$st or rth term is tabulated for $m=.1$ to 15, and $x=0$ to 37 by Pearson (1914, pp. 113–21), thus after computing the constant m for a given case, the successive terms of the series can be read off directly from his table. For example, in the expansion $(.9+.1)^{20}$ already considered $m=nq=(20)(.1)=2$ and the rth term equals $e^{-2}\left(\frac{2^{r-1}}{(r-1)!}\right)$ whose values are entered opposite those of the series in Table V.

TABLE V

TERMS OF THE BINOMIAL SERIES $(.9+.1)^{20}$, AND THE CORRESPONDING VALUES OF POISSON'S EXPONENTIAL EXPANSION

r	$r-1$ equals x	$e^{-2}\left(\frac{2^{r-1}}{\lfloor r-1}\right)$	Terms of $(.9+.1)^{20}$
1	0	.135	.122
2	1	.271	.270
3	2	.271	.285
4	3	.180	.190
5	4	.090	.090
6	5	.036	.032
7	6	.012	.009
8	7	.003	.002
9	8	.0008	.0004
10	9	.0002	.0001

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NOTES

ON A NEW METHOD OF COMPUTING FREQUENCY PERCENTAGES

By Robert E. Moritz, *University of Washington*

Suppose there be given the frequencies

$$f_1, f_2, f_3, \quad . \quad . \quad . \quad , f_n,$$

whose sum is

$$F = f_1 + f_2 + f_3 + \quad . \quad . \quad . \quad + f_n,$$

and it is required to compute the frequency percentages

$$p_k = 100f_k/F, \; k = 1, 2, 3, \quad . \quad . \quad . \quad , n.$$

The method commonly employed is to compute the ratios f_k/F by means of a slide-rule, or, if a slide-rule is not available, to compute the ratio $100/F$ and then multiply, logarithmically or otherwise, each of the numbers f_k by this common factor.

Some time ago, while spending a vacation period at an island camp, the writer unexpectedly interested himself in a statistical inquiry which involved the computation of several hundred tables of frequency percentages. Being deprived of the usual aids in computation, he hit upon the following method of approximation, which, as far as simplicity and rapidity is concerned, makes the usual aids almost, if not entirely, superfluous. Moreover, the writer is now able to show that the results obtained by this method are sufficiently accurate for all practical purposes—the method admitting, in fact, of extension so as to secure any desired degree of accuracy.

The method referred to consists of two steps.

(1) The frequencies f_k are replaced by proportional numbers f'_k whose sum F' approximates 100.

(2) The difference $D = 100 - F'$ is distributed over the numbers f'_k in accordance with the formula $\Delta f'_k = f'_k \cdot D/100$, where $\Delta f'_k$ is that portion of the difference D which falls to f'_k.

It is obvious that when $F' = 100$, there remains no difference to be distributed, and the numbers f'_k are the true frequency percentages. If, however, F' differs from 100, as is usually the case, the numbers f'_k, augmented as directed in (2), will differ slightly from the true frequency percentages, their true values being $f'_k + f'_k \cdot D/F'$, while our formula gives $f'_k + f'_k \cdot D/100$.

We shall illustrate the method by some examples before we consider the magnitude of the errors involved.

In the tables that follow, f_k represents the given frequencies, f'_k the derived frequencies obtained as directed in (1), $\Delta f'_k = f'_k \cdot D/100$, the portions of the difference $D = 100 - F'$ to be added to f'_k and $p'_k = f'_k + \Delta f'_k$, the approximate frequency percentages.

TABLE I

k	f'_k	f'_k	$\Delta f'_k$	p'_k
1	4	6.	+0.06	6.06
2	15	22.5	0.225	22.725
3	23	34.5	0.345	34.845
4	17	25.5	0.255	25.755
5	7	10.5	0.105	10.605
	$F=66$	$F'=99.0$		99.99 (check)

(1) $f'_k = f_k + \frac{1}{2} f_k$. (2) $100 - F' = 1$. $\Delta f'_k = 1\%$ of f'_k.

TABLE II

k	f_k	f'_k	$\Delta f'_k$	p'_k
1	5	6.	—0.05	5.95
2	10	12.	0.10	11.90
3	13	15.6	0.13	15.47
4	24	28.8	0.23	28.57
5	16	19.2	0.15	19.05
6	9	10.8	0.09	10.71
7	7	8.4	0.07	8.33
	$F=84$	$F'=100.8$		99.98 (check)

The results have been rounded off to two decimal places.

(1) $f'_k = f_k + \frac{1}{5} f_k$. $100 - F' = -0.8$. $\Delta f'_k = -\frac{8}{10}\%$ of f'_k.

TABLE III

k	f_k	f'_k	$\Delta f'_k$	p'_k
1	9	5.4	—0.14	5.26
2	24	14.4	0.36	14.04
3	30	18.0	0.45	17.55
4	40	24.0	0.60	23.40
5	31	18.6	0.46	18.14
6	27	16.2	0.40	15.80
7	10	6.0	0.15	5.85
	$F=171$	$F'=102.6$		100.04 (check)

(1) $f'_k = \frac{6}{10} f_k$. (2) $100 - F' = -2.6$, $\Delta f'_k = -\frac{1}{4}$ of 10% of f'_k (nearly).

TABLE IV

k	f_k	f'_k	$\Delta f'_k$	p'_k
1	18	0.72	+0.005	0.725
2	42	1.68	0.012	1.692
3	85	3.40	0.024	3.424
4	101	4.04	0.028	4.068
5	150	6.00	0.041	6.041
6	202	8.08	0.055	8.135
7	300	12.00	0.082	12.082
8	450	18.00	0.122	18.122
9	373	14.92	0.101	15.021
10	252	10.08	0.069	10.149
11	178	7.12	0.048	7.168
12	120	4.80	0.033	4.833
13	90	3.60	0.025	3.625
14	59	2.36	0.016	2.376
15	50	2.00	0.014	2.014
16	13	0.52	0.004	0.524
	$F=2483$	$F'=99.32$		99.999 (check)

(1) $f'_k=\frac{4}{100}f_k$. (2) $100-F'=0.68=0.7$ nearly. $\Delta f'_k=\frac{7}{10}$ of 1% of f'_k (nearly).

The values of p'_k are correct to three decimal places For many purposes the values f'_k give sufficiently close approximations of the values p_k.

When the method is once clearly understood, the corrections $\Delta f'_k$ need not be tabulated but may be immediately applied to the f'_k's and the results entered in the column p'_k.

Let us now consider the magnitude of the errors introduced into the values of p'_k because of (2). Let p_k represent the true values of the frequency percentages, and let

$$p_k=f'_k+c\cdot f'_k,$$

where c is the fraction of f'_k that must be added to f'_k to obtain p_k. On summing all the values of p_k we have

$$\Sigma p_k=\Sigma(f'_k+c\cdot f'_k)=\Sigma f'_k+c\cdot\Sigma f'_k,$$

from which, since $\Sigma p_k=100$, and $\Sigma f'_k=F'$,

$$100=F'+c\cdot F'$$

that is

$$c=(100-F')/F'.$$

The true frequency percentages are therefore given by the formula

$$p_k=f'_k+f'_k(100-F')/F',$$

while

$$p'_k=f'_k+f'_k(100-F')/100.$$

We may now calculate the error in p'_k, namely,

$$p_k - p'_k = f'_k(100-F')\left(\frac{1}{F'} - \frac{1}{100}\right) = f'_k\frac{(100-F')^2}{100F'};$$

also, the sum of all the errors

$$100 - \Sigma p'_k = \frac{(100-F')^2}{100F'}\Sigma f'_k = \frac{(100-F')^2}{100},$$

and the relative error

$$R = \frac{100-\Sigma p'_k}{100} = \left[\frac{100-F'}{100}\right]^2.$$

The last formula shows that in the case of the four examples given, the relative errors do not exceed 0.0001, 0.00007, 0.0007, and 0.00005 respectively. F' may therefore vary from 100 within much wider limits than in the case of the examples cited and yet yield values of p_k sufficiently accurate for all practical purposes. If F' is anywhere between 95 and 105, the relative error will be less than $\frac{1}{4}$ of 1 per cent. Moreover, it is easy to determine beforehand the limits within which F' must be chosen so as to give any preassigned accuracy to the values of p_k. For example, if the relative error is to be less than $\frac{1}{10}$ of 1 per cent, we have $\left[\frac{100-F'}{100}\right]^2 < 0.001$, from which $96.9 < F' < 103.2$.

STANDARDIZATION OF STATISTICS IN STATE INSTITUTIONS*

By Horatio M. Pollock, *New York State Hospital Commission*

The past half century has witnessed an enormous expansion of state institutions for the care of dependents, defectives, and delinquents. Prior to the Civil War there were in the United States but 24 state prisons or reformatories, 29 state asylums for the insane, and 44 state institutions for other classes. The last were principally schools for the blind and the deaf. The humanitarian movement inaugurated in the early forties by Dorothea L. Dix received new impetus upon the recovery of the states from the ravages of the war, and new state institutions rapidly sprang into being. State boards for the supervision of the several classes of dependents were created, and the policy of state care gradually became established. There are now about 600 state institutions in the United States, housing over 400,000 patients, inmates, or pupils, and representing an investment of over $400,000,000. The yearly expenditures for the maintenance of these institutions are now upwards of $100,000,000 and are rapidly increasing. Into these institutions are going each year a vast throng of mentally diseased, feebleminded, epileptic, and tubercular patients; blind, deaf, crippled, and orphaned children; delinquent youths and confirmed criminals. In the main, separate institutions are provided for each class.

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*Read at the Eighty-second Annual Meeting of the American Statistical Association, Atlantic City, New Jersey, December, 1920.

We can contrast with much satisfaction the work of these state institutions with that of the old county almshouse which in its darkest days was a veritable melting pot of public charity. Into the one almshouse went the poor of all classes—the aged and infirm, the tramp and outcast, the insane, the feebleminded, the epileptic, the blind, the deaf, and the neglected and orphaned children. The zealous overseer, with no qualification for his position except faithful support of his party, was careful to treat everybody alike and thus avoid criticism. The success of this so-called almshouse was measured by its low per capita cost and its high death-rate, although neither was accurately determined. It is indeed a far cry from such a nightmare of poor relief to the modern state hospital for mental diseases, which combines the comforts of a beautiful home with the highest degree of medical care.

Although in establishing its institutions each state has acted independently, the standards advocated by national societies have been generally adopted. There are marked variations in architectural features, but the institutions of the same class in the several states form a fairly homogeneous group.

The advantages to be derived from the coöperation of institutions forming such a group are obvious, but they have never been fully realized. Organizations such as the American Medico-Psychological Association, the American Prison Association, the American Association for the Study of the Feebleminded, and the National Committee for Mental Hygiene have done much to promote and maintain a professional spirit in the management of the institutions and to raise the general standard of treatment. More complete coöperation and coördination are greatly to be desired. In this work statisticians should have a large part. By assisting institutions of the same class in the several states to use a uniform system of records and reports, the statistician makes available for comparison a fund of information that should aid greatly the progress of the institutions and the promotion of the science on which their efficiency depends.

The inmates of state institutions, constituting as they do a great mass of human wreckage, present a challenge to students of society. Here are many sociological problems that should be studied and solved. We should not be content merely to build year after year additional institutions to house an army of new admissions, but should study the underlying causes of human failure and apply the proper remedies. We must also learn the best methods of restoring the inmates of the institutions to society as efficient citizens. Sociologists, physicians, psychiatrists, psychologists, and statisticians must join hands in an effort to throw light on the many intricate problems here presented. The statistician especially has a large duty in this field in organizing the collected data and analyzing them so that they will indicate the line of remedial action to be pursued.

Prior to 1913 no effort had been made to secure uniformity in classification of patients or inmates, or in the records and statistics of state institutions in the several states. In some states case records of patients were kept, but as the facts recorded were not standardized they were of little value for research and still less for statistics. The first productive effort to standardize statistics in state institutions throughout the country was begun by the American Medico-Psychological Association in 1913 when it appointed a committee on uniform statistics and reports. This committee after prolonged conferences finally presented a report to the Association in May, 1917, in which it recommended a standard classification of mental diseases and a uniform system of statistics for the institutions caring for the insane in the United States. The report was adopted and a special committee was appointed to work with the National Committee for Mental Hygiene in introducing the system in the state hospitals and other institutions for mental disease. The funds to carry on the work were provided by a special appropriation of the Rockefeller Foundation. Statistical record cards and a manual of instruction were provided for the use of institutions, and a standard set of tabular forms was furnished to each institution that expressed its willingness to coöperate in the movement. Marked success has attended the joint efforts of these two organizations and at the present time practically all of the state hospitals for mental disease are using the uniform system.

The improvement of the records and reports of these institutions has given encouragement to national societies working in other fields. In 1919 the National Association for the Study of the Feebleminded appointed a committee on uniform statistics which was instructed to work with the National Committee for Mental Hygiene in preparing a plan for uniform statistics in the institutions for the feebleminded in the several states. At the annual meeting of the association at Cleveland in June, 1920, the committee presented a statistical plan which met with the approval of the association, and an effort is now being made to introduce the system throughout the country. Illinois and New York have already adopted the plan, and it is probable that it will meet with general acceptance.

Important steps have also been taken to secure better statistics from state institutions for criminals and delinquents. At the annual meeting of the American Institute of Criminal Law and Criminology at Indianapolis in September, 1920, a definite plan for uniform statistics in penal and correctional institutions was adopted, and the secretary of the Institute was instructed to take steps to secure the introduction of the system in the several states. The progressive Department of Public Welfare of the State of Illinois was the first to adopt the new system, but it will probably find favor in many other states.

National associations interested in the care of the epileptic, blind, deaf, and orphaned should take similar action, and the work should be followed up until all state institutions of the same class are keeping uniform records and issuing uniform reports.

At the present time, with the exception of the statistical studies issued by the National Committee for Mental Hygiene, the only nationwide data relative to state institutions are found in the reports issued at irregular intervals by the Federal Census Bureau. These reports are of great value, but as now constituted they fail to furnish a great deal of information that should be made available each year.

To secure the desired results three lines of action are indicated:

1. The work of standardization of classifications and of records and reports should be completed for all classes of institutions.

2. Central bureaus of statistics should be established by supervising boards in each state.

3. The Federal Census Bureau should receive annual reports from the central state bureaus, and should compile and publish therefrom each year a general statistical review for each class of patients or inmates in state institutions.

If these lines of action were taken and if the statistics were planned to throw light on scientific inquiries as well as on general sociological problems, could we not confidently expect that the data gathered would result in the establishment of more efficacious methods of treatment and the development of better methods of prevention?

A single state institution working by itself is entitled to great credit when it presents the results of its yearly operations and its studies of patients accurately and in good form; the institutions of the same class in one state do better when they use a uniform system of records and combine their annual results into one state report; but the highest value of the data compiled by the institutions will not be realized until the several state reports of each class of institutions are combined into one comprehensive national review.

INTERNATIONAL STATISTICS AND THE LEAGUE OF NATIONS

By Lucien March, *Statistique Générale of France*

The League of Nations is not yet the league of all the nations. The political work connected with the League is a heavy task, fraught with difficulties thickset with sources of division. But other kinds of work enter naturally into its line of business—easier work, capable of joining the good will and raising the thoughts of peoples: that is to say, scientific studies, social work, and all that trends toward the common well-being and the maintenance of peace in the world.

The statistical work may be counted among the lines of work most helpful to the League, and which are besides absolutely necessary to its deliberations. Be it a matter of distribution of population, of public health, production of raw material, international exchange of financial problems—whatever may be the question brought before the League, statistical data, carefully collected and methodically treated, are necessary to add fresh fuel to the discussions and to justify the decisions.

A precise knowledge of the economical and social condition of peoples, their strength and productive power, would be the best guaranty for universal peace, as it would prevent the practice of underhand economical struggles which often are a prelude to political conflicts.

No wonder, therefore, that the Council of the League of Nations, soon after the ratification of the Treaty of Versailles, thought of organizing international statistics for its own use.

I

During the session in Rome in June, 1920, the Council decided to intrust an international commission with a preliminary study of this question. The report of M. Destrée, representative of Belgium, was as follows: "A conference of statistical experts, which met in London last year through the initiative of the Secretary-General of the League of Nations, expressed the unanimous opinion that it would be of great advantage if all the work in the statistical field, whose accomplishment is a necessity in the political life of nations, could be organized on a uniform and centralized system. Any attempt, however, to realize this desirable object raises problems which cannot be solved without the help of experts, both statisticians and persons who make use of statistics. I propose that, to this end, a commission be set up."

The commission was definitely appointed during the session in Saint-Sebastien. It was composed of twelve members, six of whom were representatives of organizations already existent; of these six, two were delegates of the International Statistical Institute, and each of the four others represented one of the following institutions: The International Labor Office, the International Institute of Agriculture, the International Bureau of Commercial Statistics, and the International Institute of Commerce. To these delegates were adjoined four persons in charge of official statistical organizations, and one non-designated representative of Japan.

The commission held a meeting in Paris from the 11th to the 18th of October, 1920, under the presidency of M. Luigi Bodio.* The Secretary-General of the League of Nations had prepared agenda in four paragraphs concerning: (1) the conditions of the international organizations which collect, compare, control, and publish statistics, and the need of a new coördination; (2) the necessity of appointing near the League of Nations a central advisory committee; (3) the relations between the League of Nations and the institutions existent; (4) possible improvement of international statistics and the assistance that could be given by the League of Nations.

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* M. Bodio unfortunately survived the fatigue of the journey but a few days.

Though the above decision of the Council had in no way bound the work of the commission, it has taken for the basis of its work the agenda prepared by the Secretary-General.

But since the commission was appointed by the Council, its task was first of all to enter into the designs of the Council. According to a resolution approved in Rome and sanctioned in Saint-Sebastien, it appeared that the Council wished to dispose of statistics coördinated after a uniform and centralized system. On the other hand, since half the members of the commission were delegates of existing international institutions, the Council evidently desired a close collaboration of these institutions. However, the resolutions of the Council gave no indication whatever that this collaboration was desired. At the session in Rome the Council had decided that the League would pay the "indirect expenses, in other words those incurred by organizations such as the International Labor Bureau and others fulfilling certain special tasks; these bodies work to some extent autonomously, although they depend upon the League of Nations for payment of their expenses."*

A subsidy was granted in that way to the Union of International Associations. Besides, the Council of the League of Nations in Saint-Sebastien adopted an organization of international health similar to the one proposed by the commission for international statistics. However, as nothing either in the resolutions of the Council or in the agenda of the Secretary pointed out clearly that the commission was to study in detail the organization of international statistics, the commission decided to limit its activities to what had been distinctly requested of it, that is, to confine itself to laying down principles and to pointing out the relationships of the existing international institutions to which the Council had reserved a part of influence. It was in this state of mind that most of the members exchanged opinions.

Taking up the first question proposed for study, the commission found that there were a great number (more than a hundred) of international institutions, before the war, which set up, made use of, and compared international statistics. Only a few of them publish statistics regularly. Others occupy themselves chiefly with the methods and the coördination of all the statistics in general. Most of them limit their efforts to the matter in which they are especially interested. The International Statistical Institute belongs to the first class; the International Institute of Agriculture and the other institutions represented in the Commission are examples of those belonging to the second class.

These facts being established, the commission considered its next duty to be to affirm, as heading the advices which it had to send forth, the spirit of collaboration and unification which impregnated the decision of the Council of the League of Nations. In fact, it is not sufficient to extend the field of statistical investigations; it must be made certain first that the field of facts actually observed is intelligently worked on. To that end it is of great importance that the data collected in each country may be relied upon; that their origin and the way in which they have been collected may be exactly known. The methods used in the different countries to collect the statistical facts must also be in sufficient harmony to make the signification of each fact about the same in all the countries compared. Lastly, the classifications in which the numerical facts are arranged must be, if not exactly the same, at least nearly enough alike to give a certain uniformity.

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* Official Journal of the League, no. 4, pp. 140–204.

The existing international organizations may usefully bring into coöperation particularly those persons whose studies are conducted in a purely scientific spirit, without being influenced by any material interest.

The commission, therefore, proved:

(1) That there already exists a certain number of independent international institutions which centralize and publish statistics, or which aim at unifying statistical methods and systems.

(2) That it is desirable to avoid overlapping and possible discrepancies in the figures representing the same phenomena.

(3) That the different organizations of the League of Nations find it necessary to handle statistics of various kinds in the execution of their duty, and it is extremely desirable that these various classes of statistical information should be collected on sound and properly coördinated statistical principles.

This point being agreed upon, the commission felt that it could not rely exclusively upon the international organizations; besides, these organizations—according to article 24 of the pact—are no part of the League of Nations.

Taking up the second paragraph of the agenda, the commission advised that an organization be appointed near the Council of the League to give the necessary advices concerning international statistics, and to help the League make the best use of the work already done by the international statistical institutions which keep their autonomy.

Moreover, the desired uniformity of statistics cannot be obtained without long and patient efforts; their imperfections and deficiencies are ascertained only by analyzing them and by trying to draw various conclusions. It would, then, seem to be unnecessary and harmful to await a perfect uniformity before commencing the coördination of international statistics. The reform will surely follow a deliberate and permanent setting to work: the organization which the commission had the authority to bring about may and must become the active agent of this reform.

But it is desirable that this organization ignore all interests except the truth and the scientific value of investigations. In fact, is it not to be feared that some statistics, and especially the methods used to establish these statistics, might be influenced by national tendencies or concerns, or by tendencies of classes of society, all very praiseworthy, which might come into collision, as, for instance, when it is a matter of climatological or epidemiological observations?

The commission desired to bring about this new coördination not only to collect and explain the statistics already compiled, but also to improve and develop these statistics. Now, experience teaches us that it is dangerous to wait for the urgency of events or for some special requirement before thinking of possible developments or progress. It is only by patient and methodical labor of long duration that it is possible to accomplish the work, often considerable and costly, that is required of statistical offices.

Regarding this matter two questions were considered: (1) Would the advisory council establish itself as a center for the statistics of the various countries? (2) How could the desired progress be brought about?

With respect to the first question, the advantage to be gained by the utilization of material already on hand and by the coördination of effort would seem to dictate the policy of appealing to international organizations whenever they could help effectually: and this course was decided upon. Furthermore, the commission asked that if organizations were requested to furnish work curtailing expense, the League of

Nations should pay for the expenditures. We have already stated that during the session in Rome the Council of the League had agreed to do this.

The second question increased the divergence of opinion already mentioned in connection with a preceding resolution. The necessity for studying the means of unifying and improving the methods and the classifications of international statistics was agreed upon; but some of the members thought that the principal part should be left to the Council of the League of Nations, guided by the advices of its Advisory Committee and by the wishes of the International Statistical Institute, whereas others preferred to appoint an additional assembly of statisticians.

It is natural to make use of what exists before creating new organizations. Besides, from the scientific point of view, a private institution, recruited by itself, offers more security for scientific independence than an assembly of persons appointed by the governments. The International Statistical Institute which succeeded in 1885 the former International Statistical Congresses, includes among its members the chiefs of the principal statistical offices, and some learned men who are not connected with these offices but who make use of their work. From what other classes of persons could the members of the new assembly be chosen?

The partisans of an additional assembly have supposed, without doubt, that in the proposed organization the chiefs of statistical offices would be better fitted to prevail upon their governments to institute the desired reforms than when they deliberate in the International Statistical Institute. The commission could not adopt that supposition, however. It held the opinion that motives of a political or a financial order, which in every state stand in the way of the progress of statistics, could be efficaciously opposed only by the Council of the League or by the League itself.

The commission, therefore, advised (1) that the suggestions that were to be transmitted to the different governments should be transmitted through the Council of the League; and (2) that the suggestions from the International Statistical Institute concerning the scientific point of view and the unification of methods should be solicited from the Institute.

Thus, the commission desired that the Council of the League be enlightened by the advisory committee and at the same time by the sole international organization which specially studied the questions of method. In addition, it advised that a copy of the tables that it would use be sent to the International Statistical Institute. The sending of these tables could not be construed as in any way an interference by the Institute with the work of the League of Nations or of the state statistical offices.

To compose the advisory committee the commission proposed to appoint a certain number of representatives from the principal international organizations which establish and make use of statistics. It could not do better than to have represented the institutions which the Council of the League itself had called to advise it. The commission considered it a duty, however, to appoint one more delegate each from the three most important statistical organizations: the International Statistical Institute, the International Institute of Agriculture, and the International Labor Office; and one delegate each from some other international institutions. In addition, a certain number of persons not connected with these institutions may be appointed by the Council of the League. These decisions nearly settled the principal questions, namely, the relations between the League of Nations and the existing organizations, and the assistance that might be given by the League toward the progress of statistics.

But a question was considered that was not found in the order of the day, namely, whether it would not be advisable to determine more exactly the working of the organization which had been created near the League of Nations by the preceding dispositions.

Some of the members desired to specify that the offices of that organization should form a section of the office of the Secretary-General of the League. It has been seen above that at the session in Rome the Council of the League admitted the advisability of intervention of private organizations. Besides, the commission had not been officially advised of any resolution which would justify its interference in the internal organization of the offices of the League of Nations.

Therefore the commission merely pointed out the interest that would be found in the permanence of the work of the advisory committee. It further advised that the Council, which could not have meetings of sufficient frequency, be given authority to delegate its powers, under conditions it should determine, to a permanent committee made up of some five to seven of its members.

II

With the passing of these resolutions, the commission had fulfilled the mission it had been charged to accomplish.

However, it had not treated all the questions that are to be considered in relation to international statistics and their utilization by the League of Nations. The most important of these questions is the centralization of statistics. A non-official commission, which met in London in August, 1918, resolved that question in the negative, on the supposition that the different classes of statistics would be established by different organizations. Later on, the Conference of Statisticians of the United Kingdom and the Dominions advised the contrary, and expressed itself in favor of the entire centralization. It is therefore reasonable to study the question carefully.

In the first place, it is a question that concerns each country individually, as well as a question of international interest; and each country handles it in a different way. In some countries the administration compiles the statistics. In such cases there is often a statistical council formed for the purpose of bringing about a certain uniformity in the views, the methods, and the classifications: sometimes the centralization is entire, and sometimes it exists only for certain classes of statistics.

The first system may support itself by considerations of a practical order. When it is a question of collecting the elementary data of statistics concerning a specified object, it is generally the staff of the department governing that object which collects the data. A central statistical office would not have the same authority over that staff as the department to which it belongs. And, besides, the collecting of data is, as least some part of it, an accessory element of the administrative work itself. For instance, the health administration intrusted with the notation of cases of infectious diseases in order to prepare immediately the efficacious measures to be taken, cannot fail to note the number of those cases. So one may conceive that in a particular state there might be some objections to the centralization of statistics in spite of the advantages which appear especially in an international organization, and which have determined several states to establish it completely, namely, the Netherlands, Canada, Rumania, Poland, Czecho-Slovakia; other countries have for a long time centralized their statistics to some extent.

The objections disappear entirely in international organizations. Except in some special cases, it is no longer a question of collecting elementary data: the chief purpose of the international organization is to coördinate statistics compiled by other organizations. Now, the statistics include a general technique which suits all the materials used, and a special technique for each material.

If each organization appointed for a particular class of research itself establishes and coördinates the statistics relating to that class, it is absolutely necessary that that organization should comprise an office accustomed to statistical work, able to criticize numerical data received when comparing them or analyzing their differences, and able also to draw out properly their characteristics and the relations derived therefrom. In the same manner, if a central organization is intrusted with the centralization of all the statistics, whatever may be their origin, it will have to be subdivided into groups accustomed to the various kinds of research which require a particular technique to appreciate properly the quality of corresponding numerical results.

For instance, the International Office of Public Health requires mortality and morbidity statistics, and statistics of population generally, in order to measure the danger of certain diseases, to ascertain the results of measures it recommends, etc. It is suitable that the section intrusted with the centralization of statistical data should include some clerks able to discern the characteristics of the diseases, and at the same time able to determine the terms of comparison of gathered data and to appreciate the value of these data—in a word, to utilize them scientifically.

In like manner, in a centralized organization the section intrusted with the statistics relating to the vitality of populations should include some officers able to appreciate the characteristics of that vitality, and to determine the real nature of the diseases and their classification. In this case, the question is reduced to this: It is desirable to incorporate into the health organization or into the central statistical organization the section intrusted with the statistics relating to the vitality and the sanitary conditions of the populations.

But the Public Health office is not the only organization concerned with this class of statistics. The department that studies the population, the one dwelling upon professional matters, an insurance organization, or an emigration bureau will have need of some at least of these statistics. Will it be necessary for each one of them to collect data of the same order, and in many cases, according to different methods?

In short, the question is to know whether the sections intrusted with statistics peculiar to different organizations of the League of Nations shall be placed respectively under different authorities or under the same authority. If the former plan is adopted, each section will have its peculiar tendencies, will endeavor to acquire directly the information it is interested in, under the form that seems to be the most convenient; and it will treat this information according to its own inspiration or that of the director of the organization to which it belongs. Doubtless a central commission would be created where the chiefs of the sections could confer with one another. But experience shows us that a commission is rarely an active body and that it is unsuccessful in overcoming personal tendencies, those of corporations, or the reasons for accommodation.

On the contrary, if the particular statistical sections are placed under one authority, that authority will have but one duty—to cause the rapid compilation, the accuracy, and the uniformity of data. It will be known in every country that an impartial organization, free from any political or administrative aims, or class, school or opportunity tendencies, superintends the elaboration of the statistical data supplied by all nations. Furthermore, the overlapping, and the requests from different sources relating to the same object will be avoided. Lastly, the publications will contain only comparable facts, coördinated and represented with method and in a proper scientific spirit.

For the last few years, the permanent bureau of the International Statistical Institute, which M. Methorst superintends with so much care and intelligence, has been a good example of a useful and scrupulous centralization of statistical data compiled throughout the world.

It is undoubtedly of world-wide interest to enlarge as much as possible the field of international statistics. Through statistics the nations would become more closely united, for they would know one another better. If they are accurate and impartial, statistics are an important element in bringing about reciprocal acquaintance and mutual confidence. They furnish indexes desired by parliaments, books, or the press. But hitherto no admitted authority has given to those indexes the necessary attention, or has determined the extent of their use. Would it not be one of the benefits of the League of Nations if the degree of accuracy were increased concerning the principal facts of international life? And would it not be a benefit to have an organization which, in joining for a common labor the existing international organizations without interfering with their independence, and in unifying the coördination of international statistics, would prevent overlapping, waste of time, and confused methods, and would enlarge the classifications of international statistics?

The commission intrusted by the Council of the League of Nations with the study of the scheme for such an organization has laid down the basis for it, but it has made the plans sufficiently flexible to allow the new body to be harmoniously suited to the other structures of society.

REPORT OF THE INTERNATIONAL STATISTICAL COMMISSION APPOINTED BY THE COUNCIL OF THE LEAGUE OF NATIONS

By R. H. Coats, *Dominion Statistician for Canada*

A reference to the appointment of this Commission appeared in the Quarterly for September, 1920 (page 356). The Commission consisted of representatives of the following bodies, namely, the International Labor Office, the International Institute of Agriculture, the International Bureau of Commercial Statistics (Brussels), the International Institute of Commerce, and the International Statistical Institute, together with the following persons: Lucien March (France), R. H. Coats (Canada), J. de Elola (Spain), Luigi Bodio (Italy), A. W. Flux (Great Britain), and M. Marumo (Japan).

The terms of reference drawn up by the Secretary-General of the League, as interpretive of the minute of the Council of May, 1920, were as follows:

1. To advise the Council of the League of Nations with reference to:
   (a) The extent to which the work of obtaining, collating, examining, and publishing international statistics is already carried out by international bodies;
   (b) The extent to which the published and unpublished work undertaken by these bodies requires or will require further coördination.
2. To consider and report upon the desirability of instituting a central advisory council on statistics for the purpose of advising the League of Nations concerning the coördination and standardization of statistics, and, further, to report upon the constitution and duties of such a council, should its institution be recommended.
3. To consider and report upon the relationship of the existing international statistical institutions to the League of Nations.
4. To consider in what directions international statistics require further development and in what manner the League of Nations may profitably assist such development.

The discussions extended over eight meetings, with Senator Bodio as chairman. At an early stage a difference of opinion arose as to the scope of the questions submitted to the Commission, one section regarding its business as limited to the constitution of an international advisory council on statistics, whilst the other (supported by the representative of the League Secretariat) held that the general principles which international statistical organization should follow, and the relation of the Secretariat thereto, should be taken under consideration. These and other differences developed into a Majority and a Minority Report. The resolutions supported by the Majority were as follows:

(1) *Whereas*, there already exists a certain number of independent international institutions which centralize and publish statistics, or which aim at unifying statistical methods and systems;

(2) *And whereas*, it is desirable to avoid overlapping and possible discrepancies in the figures representing the same phenomena;

(3) *And whereas*, the different organs of the League of Nations require to handle statistics of various kinds in the execution of their duty and it is extremely desirable that these various classes of statistical information should be collected on sound and properly coördinated statistical principles;

(4) The Commission is of opinion that there should be instituted by the League of Nations an International Commission of Statistics, the mission of which would be to advise the Council of the League of Nations upon the statistics of all kinds that are necessary for the League.

(5) The Commission is authorized

(a) To advise the League on all technical statistical questions;

(b) To assist the League to utilize to the utmost possible extent the work already carried out by international statistical organizations, and to assist those bodies by its advice to delimit their respective spheres; it would in each case, whenever possible, apply to the international institutions or offices which are concerned with the production of the said statistics, the said institutions to retain their autonomy;

(c) To make or transmit suggestions to the various governments through the Council of the League as to the standardization and improvement of official statistical material.

(6) The statistics produced should be delivered to the International Commission of Statistics in two copies, one of which should be transmitted to the International Institute of Statistics, in view of the suggestions that this institute might formulate from a scientific point of view and with a view to the standardization of methods.

(7) The expenses for statistics supplied at the special request of the commission by the institutes or international offices should be covered by the League of Nations.

(8) This Commission would be composed of 25 members, that is to say:

(a) Three delegates of the International Institute of Statistics and of its permanent bureau; 2 delegates of the International Institute of Agriculture; 2 delegates of the International Labor Office; 1 delegate of the International Bureau of Commercial Statistics; 1 delegate of the International Institute of Commerce; 1 delegate of the International Chamber of Commerce; 1 delegate of the Permanent Committee of Social Insurance; 1 delegate of the International Office of Hygiene; 1 delegate of the Universal Postal Union; 1 delegate of the International Telegraph Office;

(b) The Secretary-General or his delegate.

(c) The other members should be designated by the Executive Council of the League of Nations and should include representatives of the services which make or utilize statistics.

(9) The Commission shall meet whenever it may be considered desirable, or whenever it is convoked by the Council of the League of Nations. It shall meet at least once a year.

(10) In the intervals between its sessions it can delegate its powers to a permanent sub-committee composed of five of its members as a minimum, or seven as a maximum.

(11) It shall itself determine the conditions under which it delegates its powers to the permanent sub-committee.

The Minority Report, which was signed by Messrs. R. H. Coats, Royal Meeker (representing the International Labor office), and A. W. Flux, was as follows:

"The undersigned are unable to agree with the recommendations presented by the majority of the Commission. We are of the opinion that the step now imperatively needed to unify and standardize international statistics is to establish within the organization of the League a statistical section corresponding to the other technical organizations set up in the League. This the majority of the Commission did not consider to come within the terms of the reference, an opinion with which we are unable to agree, in view of the precise explanations made on behalf of the Secretariat by its representative. If any doubt remained after these explanations, further formal instructions should have been obtained from the Secretariat.

"To the statistical section above-mentioned should be attached an advisory council of statistical experts, corresponding somewhat to the proposals of the majority but differing in essentials. We believe, moreover, that provision should be made for the constitution of a general statistical assembly representing the countries of the world. Especially objectionable do we consider the explicit provision in the plan submitted by the majority for reference by the proposed advisory council to another and a private organization, namely, the International Statistical Institute. Our chief objection, however, is to the putting forward of an advisory council as a body competent to perform the urgent and difficult task involved in the coördination and standardization of statistics. This task, we repeat, can only be carried out by a properly constituted permanent office. In general, we think the report of the majority leaves matters substantially as at the conclusion of the London Conference of August, 1919. In definite terms we recommend as follows:

1. That a statistical section should be set up within the Secretariat of the League of Nations whose duties would be:

(a) To confer with the various sections of the League and other official international bodies as to the statistics required by them and to be collected by them or on their behalf;

(b) To receive from the various sections of the League such statistics as may be collected by them;

(c) To collect from governments or from other sources such additional statistics as may be required;

(d) To publish such statistics as may be thought desirable.

2. That in the execution of these duties the Statistical Section of the League should be assisted by an Advisory Council constituted as hereafter specified, whose duties would be:

(a) To advise the Section on all technical statistical questions;

(b) To assist in utilizing the work of international statistical organizations and to make suggestions with a view to delimiting their respective statistical activities;

(c) To advise the Section regarding the transmission of suggestions through the Council of the League to the various governments for the standardization and improvement of official statistics.

3. The Advisory Council should be composed as follows:

(a) Each of the members of the Council of the League of Nations should be represented by one statistical expert;

(b) Each of the following organizations should have one representative: the International Agricultural Institute, the International Labor Office, the Bureau of Commercial Statistics, and the Institute of Hygiene;

(c) A representative of the International Statistical Institute;

(d) A representative of the Secretary-General of the League who should be chairman of the Council.

4. There should be summoned at such times as may seem desirable, and, in general, at intervals not exceeding three years, a conference representing the statisticians of all nations to express their opinion upon matters of statistical importance. The agenda of such meetings should be circulated four months in advance of the meetings.

"In further explanation of the above, we would add the following suggestions:

"The Statistical Section of the Secretariat should be under a director and also an assistant director (in view of the heavy administrative task) and should otherwise be adequately staffed and equipped. Emphasis should be placed on the technical qualifications of the staff. The director should be the secretary of the Advisory Council.

"It is contemplated that the members of the Advisory Council under section 3 (a) would secure advice in reference to matters under consideration by consultation with the statistical experts of their respective nations.

"The Assembly should consist of a representative from each member of the League accompanied by an adviser or advisers if thought necessary, in order to permit of classes interested in the use as well as the production of statistics. An assembly should be held within one year of the setting up of the statistical section. The primary object of the Assembly should be to bring international statistics into direct contact with the opinion of statisticians throughout the world, the assemblies and governing bodies of most existing international organizations being gatherings primarily of non-statisticians. On the side of statistical technique the records of the International Statistical Institute are evidence of the valuable results which flow from broad-based discussions; when such results are the product of official as well as private initiative, their practical application, it may be expected, will be more general. The Majority report makes no provision whereby every country may secure a voice in the formulation of international statistical policy.

"In conclusion we would emphasize the opinion that the problem of statistical organization should in the final analysis be approached as an entity, especially in a world-plan which is dependent upon the support of sovereign bodies not disposed to accept confused or wasteful methods, and that there should be recognition at the outset of the character of the working machinery which alone can accomplish that purpose."

The question of procedure offered considerable difficulties. At the end of the sessions the resolutions, as above set forth, were forwarded to the Council of the League, but it was decided that the drawing up of the Commission's report should be carried out by a member of the Majority, subsequent to the adjournment of the Commission, for submission to the individual members for comment thereon. The Minority members thereupon forwarded the statement above quoted to the Secretary-General of the League for presentation to the Council at the same time as the Majority resolutions.

The reports of the Commission were placed before the Council of the League at its meeting in Brussels during October and were by it referred back to the respective governments included in the League.

FRENCH WAR FINANCE

By Faith M. Williams, *Federal Reserve Board*

The Division of Analysis and Research of the Federal Reserve Board has recently completed a study dealing with French war finance. The subject is of especial interest at the present time because of the effect of the French war debt upon present economic and political problems in Europe.

In France's 1920 budget the second largest item of expenditure is that for "the expenses of the public debt" which amounts to almost twelve billion francs. This figure, which is larger than the total French tax receipts in 1919, brought the budget for the "ordinary expenditures" of the French government last year up to almost twenty-two billion francs. In June, 1920, new taxes were enacted which are expected to yield enough revenue to balance this "ordinary budget." There remained, however, after this was done, the expenses connected with pensions, with war-time cost of living bonuses, and with the reconstruction of the devastated regions, which amounted to twenty-six billion francs. Of this amount twenty-one billions were regarded as eventually recoverable from Germany. It was necessary to meet this "extraordinary expenditure" by two internal loans. The 1921 budget contemplates spending 16 billion francs more in the devastated regions, and, in default of any considerable payments by Germany on reparations account, raising that amount by further loans. Since the French public debt now totals about 245 billion francs it does not seem astonishing that the French people do not look upon further additions to their debt with enthusiasm, and that they are very eager for payments from Germany to begin.

France entered the war with a comparatively insignificant internal debt (about 35 billion francs) and with large investments abroad. She begins the year 1921 with a debt at home and abroad which amounts to about 245 billion francs, calculating her foreign debts at par. A survey of the process by which this debt was piled up makes an interesting study in war finance.

At the beginning of the war the mobilization of almost all Frenchmen of military age completely disorganized the collection of taxes, and French tax receipts for 1914 fell 641 million francs below budget estimates. The invasion of French territory and the occupation of her most profitable industrial region prevented France from floating a great loan at the beginning of the war.

In 1914 her two great sources for current funds were advances from the Bank of France and the sale of three months, six months, and one year Treasury Bills, which were re-named in November, 1915, National Defense Bills. Upon these two sources she depended until 1915. In that year her methods of war-financing developed, and she marketed five and ten year bonds and floated a consolidation loan. By 1916 her system of war finance had been completely evolved. From that time on no new expedients were invented, but the old forms were used over again.

Specifically, seven different sources were utilized to provide funds for the French government during the war. They are as follows:

(1) Receipts from taxes.

(2) Advances from the Bank of France and the Bank of Algeria.

(3) National Defense Bills (Bons de la Defense Nationale, issued first for one year, six months, three months, and later for one month also).

(4) National Defense Bonds (Obligations de la Defense Nationale, five and ten year bonds).

(5) Consolidation Loans. (These loans were all of the "perpetual rente" type except that of the spring of 1920 which matures in 1980.)

(6) Treasury Bills discounted abroad.

(7) Other Loans floated abroad.

France used short term government securities as a means of obtaining war funds much more than has popularly been supposed. Her National Defense Bills correspond to the Certificates of Indebtedness used in the United States and the Treasury Bills of the United Kingdom. They were sold during the entire period of the war, in constantly increasing amounts. The only times when they showed marked decreases were when the Consolidation Loans resulted in the funding of large amounts of the bills outstanding. (The National Defense Bills were accepted as equivalent to cash in subscriptions to loans.) In December, 1919, there were National Defense Bills in circulation to the amount of 46 billion francs, and the latest figure available (that of July 1, 1920) is 44 billion francs. Figures on the amounts floated in the last six months and the amounts paid into the last loan since that time seem to indicate that the bills outstanding in December, 1920, amounted to more than 46 billion francs.

The most striking feature of French war finance is furnished by the advances of the Bank of France to the government, and the consequent increase in its note circulation. It should be observed, however, that at no time during the war did the advances of the Bank of France equal the amounts realized from the sale of National Defense Bills. According to the agreement by which the bank is the only note-issuing body in France, it was required to advance the government, until the expiration of the note-issuing privilege, 200,000,000 francs without interest, and "in time of public emergency" to lend 2,900,000,000 francs at 1 per cent. This was promptly done at the outbreak of the war.

It was evident very shortly, however, that the advances originally agreed upon would not be sufficient for the needs of the state, and in September, 1914, the limit was raised to 6 billion francs. The maximum was again raised in May, 1915, and it has progressed by successive steps until it now stands at 27 billion francs, not including Treasury Bills discounted for the advances of the state to foreign governments.

The only periods during the war when the advances of the bank decreased were at the time of the Consolidation Loans (December, 1915; November, 1916; very slightly in December, 1917; September, 1918), and at the time of the armistice. The increase in the advances of the bank to the state in 1919 is very striking. There was no great loan during that year to fund the outstanding obligations of the government, and expenditures piled up faster than tax receipts, although the latter were larger than they had ever been before. During 1920, however, the advances of the bank increased very slightly, and during January, 1921, they decreased by about one billion francs.

The advances to the government caused a large increase in the note circulation of the bank. There is no legal reserve ratio for the Bank of France, but the amount of its note issue is limited by act of Parliament. When the war broke out, this limit stood at 6,800,000,000 francs, but it has since been raised several times, and is now 43,000,000,000 francs.

The decrease in the ratio of gold to notes of the Bank of France is not quite so great as the increase in its note circulation would seem to imply, as its gold reserve has increased almost 2 billion francs since 1914. In December, 1913, the gold reserve of the bank amounted to 3,517 billion francs; in December, 1920, it had reached 5,500 billion francs (including 1,948 million francs held abroad).

Gold convertibility in France was abandoned by an act of Parliament in August, 1914. Bank notes were made legal tender, and issued in 5 and 20 franc denominations to take the place of the coin withdrawn from circulation. There has been a very close correspondance between the advances of the Bank of France to the government and the increase in its note circulation during the war. In the last week in January, 1921, the note circulation stood at 37,913 million francs, and the advances to the state at 29,780 million. The difference (6 billion francs) is only slightly more than the entire note circulation of the bank in 1914.

A third feature of French war borrowing which is of especial interest is that which concerns foreign countries. The report of foreign debts given to the French Senate last July lists ten allied and neutral countries from which she received the loans by which she financed her necessary imports. In most of these countries the loans took the form of short term credits and must be repaid within a year or so. In England and the United States the greater part of the advances came from the national treasury and may presumably be allowed to run for a longer period.

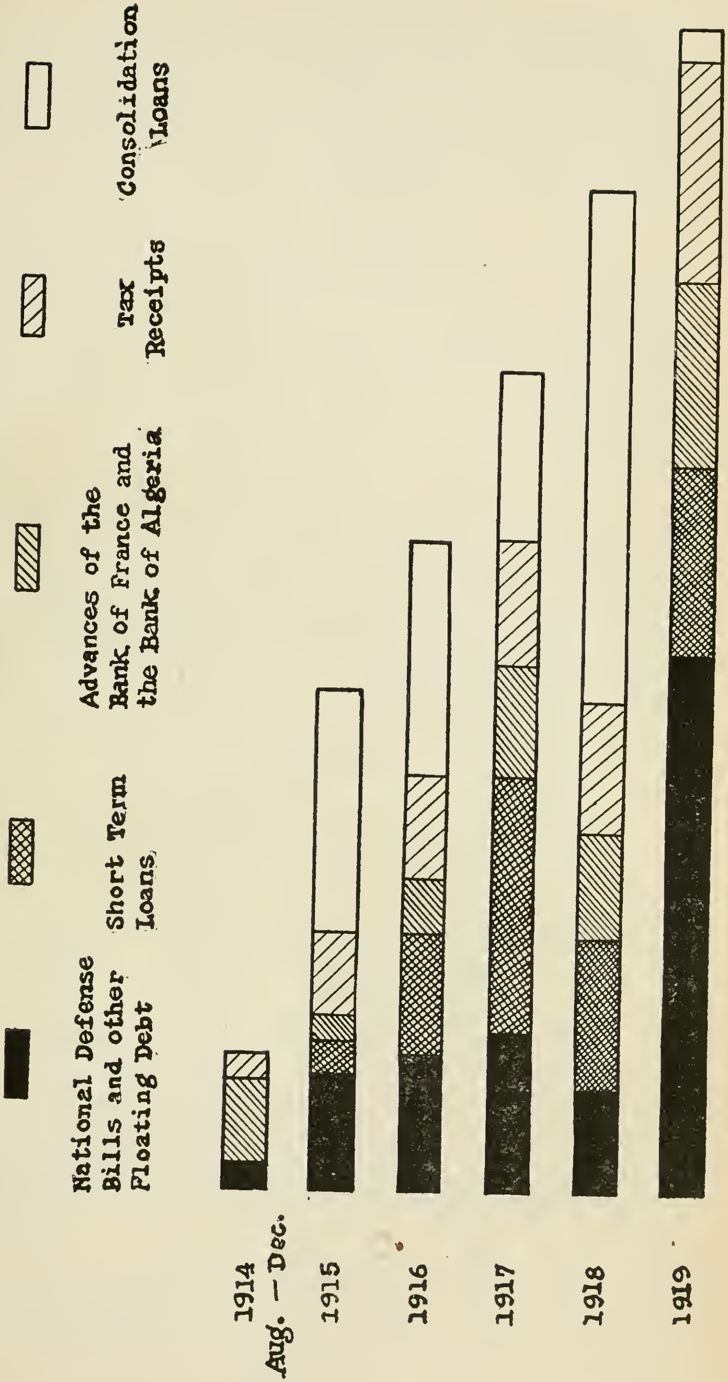
On July 1, 1920, the principal items of the foreign debt were as follows:

FRENCH FOREIGN DEBT AS OF JULY 1, 1920

(In millions of francs)

Bills discounted by the British Treasury	12,327
Bills discounted by the Bank of England	1,639
Advances of the American Treasury	14,428
Anglo-French Loan in the United States	1,295
Bonds given to the American Government in exchange for army stocks	2,072
Short term credit in Spain	593
Other short term credits in neutral countries	954
Other loans	988
Total (all debts calculated at par)	34,296

PRINCIPAL RESOURCES OF THE FRENCH TREASURY



Since the beginning of the war there have been six consolidation loans in France, all but one of them being of the "perpetual rente" type long familiar in France. Only the last loan was issued, strictly speaking, at par, for although interest on the 5 per cent loan of 1920 is paid only on the capital invested, this loan must be repaid at 150 at its maturity. The difference between the amounts actually received in each loan and the amount upon which interest is being paid is shown by the following table.

FRENCH CONSOLIDATION LOANS

(In millions of francs)

Loans	*Nominal capital (face value)*	*Effective capital (amounts paid in)*
5% 1915	15,205	13,308
5% 1916	11,514	10,082
4% 1917	14,882	10,209
4% 1918	31,304	22,163
5% 1920	16,150	16,150
6% 1920	27,000	27,000
Total	116,055	98,912

In order to get a clear picture of the financial operations of the French government during the war, it is profitable to place in parallel columns the resources utilized by the French Treasurer during the five years of the war and the first year after the armistice. The figures for the war years were first published in the 1919 report on the French budget, and those for 1919 were calculated from the figures of M. Klotz, formerly French Finance Minister.*

PRINCIPAL RESOURCES OF THE FRENCH TREASURER

(In millions of francs)

Date	*National defense bills and other floating debt*	*Short term loans*	*Advances of the bank of France and bank of Algeria*	*Tax receipts*	*Consolidation loans*
1914					
Aug.–Dec.	1,124	0	3,900	1,235	0
1915	5,298	1,511	1,175	3,771	10,967
1916	6,244	5,580	2,450	4,641	10,720
1917	7,214	11,709	5,060	5,811	7,670
1918	4,564	7,054	4,780	6,006	23,584
1919	24,542	8,560	8,635	10,000	1,417

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* No regular reports are published by the French Treasury, and official figures on French war finance must be obtained from the Documents of the Senate and the Chamber of Deputies. At varying intervals there occur in these Documents statements of the government's financial situation. The statements are sometimes made by the Finance Minister and sometimes by the Chairman of the Senate or Chamber of Deputies Finance Commission. One of the most complete and satisfactory of these reports is that prepared in July, 1920, by M. Doumer who has recently become Finance Minister in the Briand Cabinet.

PROCEEDINGS OF THE 82ND ANNUAL MEETING OF THE AMERICAN STATISTICAL ASSOCIATION

ATLANTIC CITY, N. J., DECEMBER 29–30, 1920

PROGRAM

WEDNESDAY, DECEMBER 29

10.00 A. M.—Morning Session

Topic: Population and Vital Statistics

Paper: Some Recent Morbidity Statistics in Industry,
Edgar Sydenstricker, U. S. Public Health Service

Discussion:
William A. Hathaway, American Telegraph and Telephone Co., New York
Willford I. King, National Bureau of Economic Research, New York

Paper: Conduct of the Office and Field Work of the Fourteenth Census,
William M. Steuart, Assistant Director of the Census

Discussion:
Raymond Pearl, Johns Hopkins University
Walter Laidlaw, Executive Secretary, New York City 1920 Census Committee

Paper: Standardization of Statistics of State Institutions,
Horatio M. Pollock, Statistician, New York State Hospital Commission

Discussion:
Edith M. Furbush, Statistician, National Committee for Mental Hygiene
Eugene B. Patton, Statistician, New York State Industrial Commission

Paper: Work of the Paris Conference on the Revision of the International List of Causes of Death, George H. Van Buren, Supervisor, Statistical Bureau, Metropolitan Life Insurance Co., New York, Delegate of the Association to this Conference called by the French Government, October 11, 1920

2.30 P. M.—Afternoon Session

Paper: Underlying Considerations in Wage Determinations for Industry,
William A. Hathaway, American Telegraph and Telephone Co.

Discussion:
William F. Ogburn, Columbia University

Paper: Reduction to Practice of Some Phases of Industrial Medicine,
Dr. C. H. Watson, American Telegraph and Telephone Co.

Discussion:
Bernard J. Newman, United States Public Health Service, Washington

Paper: Industrial Education and Training,
J. W. Dietz, Western Electric Co., New York

Discussion:
C. R. Dooley, Standard Oil Company of New Jersey

9.00 P. M.—Evening Session

President's Address, George E. Roberts, Vice-President, National City Bank, New York

10.00 P. M.—Smoker

THURSDAY, DECEMBER 30

9.00 A. M.—Business Meeting

Election of Officers, Reports of Committees, etc.

10.30 A. M.—Morning Session

Topic: Index Numbers

Paper: What is the Best Form of Index Number? Irving Fisher, Yale University (Illustrated with lantern slides.)

Discussion:

Ethelbert Stewart, Commissioner of Labor Statistics
Wesley C. Mitchell, New School for Social Research, New York
Warren M. Persons, Harvard Committee on Economic Research, Harvard University
Correa M. Walsh, Bellport, Long Island
Walter W. Stewart, Amherst College
F. Leslie Hayford, Economic Statistican, Du Pont Company, Wilmington, Del.

2.30 P. M.—Afternoon Session

Topic: The National Income and Its Distribution

Paper: A National Money Accounting as the Basis for Studies of Income Distribution, Malcolm C. Rorty, Statistician, American Telegraph and Telephone Company, New York

Paper: Variation in the National Real Income, Edmund E. Day, Harvard University

Discussion:

Carl Synder, Statistician, Federal Reserve Bank of New York
David Friday, University of Michigan
Walter R. Ingalls, Consulting Engineer, New York
Leo Wolman, New School for Social Research, New York
Nicholas Kelly, Assistant Secretary of the Treasury, Washington, D. C.

Minutes of the Annual Business Meeting

Meeting called to order at 9. A. M., December 30, 1920, President George E. Roberts presiding.

Reports were submitted as follows:

Report of the Secretary for 1920

The following report is submitted with respect to the condition of the Association:

Membership December, 1919			869
Additions during 1920:			
New members	210		
Corporate members	4		
Total		214	
* Deductions during 1920		95	
Net gain during 1920			119
Membership December, 1920			988

* Above deductions during 1920 are distributed as follows:

Deaths reported during the year	6
Resignations during year	32
Dropped because unable to locate	21
Dropped for non-payment of dues	36
Total	95

Besides members we have:

Subscribers, mostly libraries	258
Domestic exchanges	21
Foreign exchanges	61
Total members, subscribers and exchanges	1,324

The death of the following members has been reported during the year: O. C. Barber, Edwin M. Bliss, A. F. Estabrook, William H. Gove, George D. Leslie, H. E. Vineberg.

Four numbers of the publications have been issued during 1920, containing an aggregate of 531 pages, as compared with 331 pages during 1919.

Two special meetings of the Association have been held during the year, in April and November. The attendance at these meetings was 72 and 142 respectively.

Respectfully submitted,

ROBERT E. CHADDOCK, *Secretary.*

REPORT OF THE TREASURER FOR 1920

Receipts

Membership dues		$3,182.60	
Sales, single copies of the QUARTERLY		362.29	
Sales, Memorial Volume:			
Sales to members	$143.48		
Sales through Macmillan Co.	253.72		
Total		397.20	
Subscriptions to QUARTERLY		749.89	
Dividends on B. & A. Stock		148.75	
Balance on hand at first of year		659.47	
			$5,500.20

Expenditures

Printing:			
Printing QUARTERLY Publications:			
December, 1919	$501.22		
March, 1920	776.10		
June, 1920	580.70		
September, 1920	460.30		
(Part payment $500 still due)			
Handbook of members	219.62		
Total	$2,537.94		
Other printing expense, stationery, etc.	395.28		
Total Printing		$2,933.22	
Postage		173.55	
Salaries		1,141.65	
Part payment on $1,500 Memorial Volume loan		700.00	
Interest on Memorial Volume loan		80.53	
Expenses, miscellaneous		247.69	
Balance on hand December 21, 1920		223.56	
			$5,500.20

REPORT ON MEMORIAL VOLUME FUND 1920

Receipts

Balance from 1919	$56.11	
Sales to members at special rate ($3.50)	143.48	
Sales through Macmillan Co.	253.72	
Deficit paid out of general funds	338.89	
		$792.20

Expenditures

Printing circulars	$11.67	
Part payment on $1,500 loan	700.00	
Interest on loan	80.53	
		$792.20

Payable

The Association has $800 loan on account of the Memorial Volume still outstanding with the Corn Exchange Bank, New York. It also owes the Rumford Press $500 for printing, due on the September issue.

Assets

Seventeen shares Boston & Albany R. R. stock deposited as collateral with the Corn Exchange Bank, for Memorial Volume loan. Unsold copies of the Memorial Volume.

ROBERT E. CHADDOCK,
Treasurer.

REPORT OF THE AUDITING COMMITTEE

We have audited the accounts of the Treasurer of the American Statistical Association as of the close of business December 20, 1920, and find all disbursements properly accounted for by cancelled checks and vouchers. We have also verified the treasurer's record of receipts and disbursements, as shown by his books, with the cash balance on hand, as shown by the bank statement, and find the same in agreement.

As is customary, we have made no audit of accounts payable and receivable.

DONALD R. BELCHER,
B. F. YOUNG,
Auditing Committee.

The reports of the Secretary-Treasurer and Auditors were accepted and ordered printed in the proceedings.

REPORT OF THE EDITOR OF THE QUARTERLY PUBLICATIONS

The editor outlined the plan, already in progress during the past year, for improving the QUARTERLY by developing a section on reviews and notes and sources of statistical information, and for keeping the editorial committee more closely in touch with the statistical work being done in various fields. He pointed out that it would be desirable to offer a limited number of reprints, free of charge, to authors contributing to the QUARTERLY. Suggestions have come to the editor during the year concerning a change of name for our publications. The proposed names were considered and the Association authorized the Secretary to submit to the members of the Association the following names for vote of preference, a report to be submitted at the next annual meeting: Journal of the American Statistical Association; American Statistical Quarterly; American Statistical Review; Statistical Association Quarterly.

REPORTS OF COMMITTEES

THE JOINT ADVISORY COMMITTEE ON THE CENSUS

The report of the Joint Committee of the American Economic and the American Statistical Associations was presented and accepted, as printed in the Quarterly Publications for December, 1920. The Association adopted the following resolutions with reference to this report:

In accepting the report of progress of the Joint Committee to advise the Director of the Census, the American Statistical Association desires to record its hearty approval of the policy of eliminating nearly all the text from census publications for the purpose of hastening the appearance of the bulletins and final reports of the Fourteenth Census, a policy adopted by the Bureau of the Census after conferences with the Joint Committee.

The Statistical Association, further, approves the recommendation made by the Joint Committee to the Bureau of the Census that it prepare and publish systematic scientific analyses of the census results in the form of monographs on the more important census topics. These monographs should be prepared by the Bureau of the Census with the coöperation of specialists in the various topics selected for treatment.

The representatives of the Statistical Association are hereby authorized to urge this policy and to express the conviction of this Association that an adequate interpretation of census figures constitutes an essential and in many respects the most significant part of the work upon the census.

REPORT OF THE COMMITTEE ON FELLOWS

Carroll W. Doten, Chairman, reported the agreement of the Committee in electing the following members as Fellows of the Association, as authorized by Article V of the Constitution: F. Stuart Chapin, Roland P. Falkner, Abb Landis, William F. Ogburn, Raymond Pearl, and Ethelbert Stewart.

REPORT OF THE COMMITTEE ON BUSINESS STATISTICS

The Committee on Business Statistics during the past year has continued the activities outlined in its report for the year 1919. The concrete results obtained include the preparation, and practically the final acceptance by the Boot and Shoe Manufacturers Association and the Automobile Chamber of Commerce, of schedules covering the output of boots and shoes and of automobiles. These schedules have also been discussed informally with representatives of the Division of Manufactures of the Bureau of the Census.

The next step following the preparation of these schedules will be to secure, particularly as to statistics of automobile production, the necessary legislative authority and appropriations to enable the Bureau of the Census to undertake the compilations. The pressure of work on the Census Bureau in connection with the 1920 census, as well as the pressure of other business on Congress, has, however, made it seem desirable to withold action in this respect until after the close of the present year. Several consultations have, nevertheless, been held with the officials of the Chamber of Commerce of the United States in order to secure their support for the necessary legislation. It is believed that such support can be counted upon, and that final action should be secured during the winter or spring of the year 1921.

In addition to the preceding activities of the committee, there has been a rather extensive discussion, with the Chamber of Commerce of the United States and various trade associations, of the possibility of securing the setting up of a number of other indices as to which primary compilation would be made by the trade associations.

Efforts along this line offer a promising field for the work of the committee during the ensuing year.

Owing to the increasing interest in statistical research on the part of business concerns, it is the belief of the committee that it should not attempt to cover the entire field of business statistics, but should be known as "The Committee on Business and Production Indices," and a change of title of the committee in accordance with this suggestion is recommended.

REPORT OF THE COMMITTEE ON NOMINATIONS

The report of the Nominating Committee, consisting of Edmund E. Day, Chairman, Joseph A. Hill and N. I. Stone, was presented for final action. The Secretary was instructed to cast one ballot for the nominations as presented. The following officers for the year 1921 were declared elected: President, Carroll W. Doten; Vice Presidents, Ernest S. Bradford, Louis I. Dublin, William M. Steuart; Counsellors, Raymond Pearl, Warren M. Persons, Malcolm C. Rorty; Secretary-Treasurer, Robert E. Chaddock; Librarian, Horace L. Wheeler; Editor, William F. Ogburn.

Change of Membership Dues

The Association voted to amend by-law two in such a manner as to read, "Each regular member shall pay annual dues of *five dollars*, or *fifty dollars* at some one time, each fellow shall pay annual dues of five dollars, or fifty dollars at some one time, and each corporate member shall pay annual dues of one hundred dollars."

The Association voted to appropriate $600, as provided last year, for securing assistance in the office of the Secretary-Treasurer.

The Association referred to the Board with power the matter of change in the rate of subscription to the Quarterly Publications and of the time when such rate should be made effective.

The Board was instructed to make investigation as to cost of printing our publication and all possible means of reducing printing expenses.

The matter of providing appropriate organization to meet the needs of business statisticians in their fields of research was discussed informally and left to the Board to work out, under the power given by the by-laws, section three, to organize Committees.

Robert E. Chaddock,
Secretary.

THE CENSUS OF THE ITALIAN POPULATION FOR 1921

In all of the ex-belligerent nations the first census to be taken after the declaration of peace will be of the greatest importance as it will make known, with exactness, the great changes in population caused by the war. But in Italy the next census assumes a special importance because it consecrates the completion of Italian National Unity in the annexation of lands which for centuries have been dear to every Italian heart. The Superior Council of Statistics, at the meetings held from November 20 to 24, defined the regulations according to which this census shall be conducted. It will be started December 1, 1921, and this date will be kept thereafter for future censuses, which will follow at intervals of ten years.

This census will be a purely demographic one for ascertaining the population only. The combining of such a census with that of the industrial census in 1911 did not bring good results; it was therefore deemed advisable by the Supreme Council to eliminate therefrom the industrial census. In consequence of this decision, other censuses probably will be taken (industrial properties, habitations, etc.) so as to furnish continuous work for the census office, which will thus become a permanent institution instead of a provisional arrangement as in the past. The possibility of economy by the use of calculating machines has suggested the abandonment of the system of individual bulletins for the family schedule. These will probably be done by the Powers machine.

The questions to be asked on this family schedule have not been formulated definitely as yet. At the session of the Superior Council of Statistics a permanent committee was appointed, consisting of Professors Benini, Gini, and Montaro, the Hon. Beneduce, and Dr. Aschiari, directors of the Central Office of Statistics. One of the duties of this committee will be the preparation of the family schedule. The Superior Council will have the final decision, however.

Questions concerning the sick (blindness and deafness) will be omitted, and the gathering of data about the killed in war, the mutilated, the decorated, etc., will be taken care of in the special statistics soon to be prepared by the Minister of War. In place of these questions, a new one will be introduced regarding the number of children borne by each mother, and the date of birth of the first child. The schedule will also include a question concerning the use of the Italian language in the homes of the people. If this question is answered in the affirmative, the reply must be made in the Italian language. This last question has been adopted in order to determine with exactness the number of the population speaking a foreign language within the boundaries of the country.

There will be several other specific questions. The one concerning literacy will ascertain not only whether a person can read, but also what studies he has completed. A person will be asked in what religion he was reared and what religion, if any, he professes then. With this new questionnaire not only persons regularly married (civil and religious) will be recorded, but also those married only by the religious ceremony, as well as those of Common Law unions. These questions are deemed advisable because of the increasing number of these Common Law marriages permitted as legal during the war. It was also considered important by the Council that the census should be furnished with a classification of the professions which would serve as a reliable guide to the people, and would secure uniformity for the judges who direct them.

The Superior Council, in closing, voted that contemporaneously with the population census of the kingdom a census of the colonies (Tripoli, Cirenaica, Eritrea, Somalia) should also be taken, as well as one of all Italians residing in foreign lands. In the accomplishment of this last, two methods will be resorted to: (1) Assistance will be asked of the consular authorities, commercial agencies, emigration inspectors, and coöperative Italian societies in foreign countries; and (2) census enumerators will obtain from the inhabitants of the kingdom the names of their relatives residing in other countries. These and other points of interest will be considered at future meetings of the Supreme Council. The date of the next meeting was to be announced by the first of January, 1921.

C. GINI.

THE INTERNATIONAL LABOR OFFICE

Of considerable interest to the members of the American Statistical Association are the announcements that have recently come to America of the activities and publications of the International Labor Office of the League of Nations whose headquarters are at Geneva, Switzerland. The regular periodical publications are three: the *Monthly International Labor Review*, the *Bulletin*, and the *Daily Summary.*

The *Monthly International Labor Review* appears in January, 1921, and is to be published in French and in English. "It is to be a scientific tabular publication containing articles, statistics, and information relating to labor and industry of interest and value to employers, workers, and governments. It will contain contributions by well-known economists, employers, and trade union leaders as well as articles prepared in the International Labor Office."

The *Bulletin* is a weekly publication and has appeared regularly since September, 1920, in French and in English, and since October in German. The purpose of the *Bulletin* is to supply information with regard to the activities of the International Labor Organization. "It contains the texts of official documents, reports of meetings of the governing body and the various international commissions (on unemployment, emigration, etc.) as well as general information with regard to the progress of the office. It also contains particulars with regard to the action taken by the different nations, members of the organization, to give effect to the decisions of the Annual Conference."

The *Daily Summary* has appeared since September 1, 1920, and is published in French and in English. It contains brief notes on important current events relating to labor and industry.

Of the irregular periodical publications there are four types: studies and reports, bibliographical series, legislative series, and reports of the International Labor Conference. The studies and reports contain short reports and articles on subjects of immediate importance and fall into the following fourteen series: (a) industrial activity in its relation to questions of labor; (b) economic relations; (c) employment and unemployment; (d) conditions of labor; (e) social insurance; (f) safety; (g) industrial hygiene; (h) conditions of life of the workers; (i) coöperation; (j) protection of women and children; (k) education; (l) agriculture; and (m) questions affecting seamen. Twenty or more of these special reports and studies have already been published. The bibliographical series contain general bibliographical lists of publications, both official and non-official, and special annotated bibliographies relating to particular subjects. The legislative series is a continuation in a new form of the series formerly published by the old International Labor Office at Basle. A good many of the texts of laws, decrees, orders, and regulations affecting labor in various countries have already been published.

The non-periodical publications consist chiefly of special reports which are the results of important special investigations or researches by the International Labor Office. Similar studies made outside the office may also be published. There have already been published special reports on *Labor Conditions in Soviet Russia* and *An Introductory Memorandum on Production.* This latter publication brings into comparison statistics relating to production, prices, transportation, exchange, hours of labor, and kindred matters having to do with labor costs and production per man in several of the more important industrial countries of the world.

FLORENCE NIGHTINGALE CENTENARY

The one-hundredth anniversary of the birth of Florence Nightingale occurred on May 12, 1920. The event was celebrated throughout the United States and Canada by schools of nursing and by medical and public health societies. Emphasis was placed in these celebrations upon the achievements of Miss Nightingale in founding the profession of skilled nursing, in hospital reform, and in the reorganization of military medicine. It seems fitting that at this time acknowledgment should be made of some of her more important contributions to the vital and social statistics of the nineteenth century.

The more significant lessons from the statistical work of Florence Nightingale can be applied at the present time when our libraries are fairly bulging with volumes of sterile tables and text, the result of the stimulation of registration and investigative activities by various community interests in the past few decades.

Miss Nightingale contributed to the progress of official and private statistics in two important respects: first, in being responsible for a plan of uniform hospital records and statistics, for an attempt to extend the scope of the British Census of 1861 so as to include housing and sickness data, for the outline of sanitary statistics of the British Army, afterward put into effect by Dr. Thomas Graham Balfour, for the schedules and tabular practice of the stational sanitary reports of the Army in India, and for numerous other purely technical procedures in vital statistics; second, she gave a practical demonstration of the *use* of statistics, in the marshalling of tabulated materials, the graphing of essentials, and in the preparation of compelling, result-bringing text. A thorough reading of the report "Notes on Matters Affecting the Health, Efficiency and Hospital Administration of the British Army" is to be recommended to our American students of statistics in order that they may become acquainted with the elements of the Nightingale style,—clearness, force, simplicity, and the special characteristic "humorous subacidity." "Statistics for statisticians" were, to her mind, an abomination. *Analyses* of tabulated facts on sanitation and on the conduct of public affairs were to her a lever for overcoming the inertia of the legislative mind, of smugly buttressed officialdom, and of an amorphous public conscience.

The Nightingale Centenary should direct the attention of American teachers of statistics to the necessity for shifting the point of view of statistical practitioners. There should be greater emphasis upon ends to be served, and less upon ways and means of compiling data. A survey of statistical activity in America today would perhaps show that much of our effort is aimless. There is laborious and expensive endeavor to produce ponderous tomes, and then feverish activity to find a market for the product. There seems to be a need for a statement of the kinds or sorts of facts, of new methods of analysis and presentation, and for style elements, which will bring results other than the cluttering of library shelves. And in the Nightingale style, one detects more or less the influence of Quetelet, of Farr, and of Laplace. Miss Nightingale was an eager student of the great Belgian's work. This suggests that American students of statistics are not taught the significance of the work of these three pioneers of nineteenth century statistical science. It would be perhaps more profitable to abandon some of the precepts of the young American "school" which imitates the German encyclopedists, and get back to Quetelet and Laplace.

M. A. NUTTING and E. W. KOPF.

MISCELLANEOUS NOTES

International Eugenics Congress. Following the First International Congress in Eugenics that was held in London in August, 1912, there is to be held a Second International Congress of Eugenics in New York City, September 22–28, 1921. The headquarters of the congress will be in the American Museum of Natural History. The honorary president of the congress is Alexander Graham Bell; the president, Dr. H. F. Osborn; treasurer, Madison Grant; and secretary general, Dr. C. C. Little, of Cold Spring Harbor, N. Y. The work of the congress is divided into four sections. The first is devoted to studies in human heredity, including also research in the domain of pure genetics in animals and plants, which will throw light upon human heredity. In this section may be received also certain papers on the physiology of reproduction. The second section will consider factors that influence the human family, and the control of such factors; the relation of fecundity of different strains in families, and the question of social and legal control of such fecundity; also the differential mortality of the eugenically superior and inferior stocks, and the influence upon such mortality of special factors, such as war and epidemic and endemic diseases. Mate selection will be stressed. The third section is concerned with human racial differences. Here will be considered the facts of the migrations of races, the influence of racial characteristics on human history, and the teachings of the past with its bearings on the policy of the future. The fourth section will discuss eugenics in relation to the state, to society, and to education. "In each section the Congress will present carefully worked out facts and the immediate and practical conclusions to which they lead." Special stress will be laid upon the results of experimental and statistical research. The importance of the intellectual, social, and economic aspects will, of course, be pointed out in the section devoted to these various fields. All foreign papers should be in the hands of the secretary general not later than May first, and all papers from Canada and the United States not later than June 15. Foreign governments and many universities and learned societies have been asked to send delegates.

Reports on Operating Expenses in Retail Trades. The Bureau of Business Research, Harvard University, during the last year has issued reports on operating expenses in the retail shoe, grocery, hardware, drug, and jewelry trades, and in the wholesale grocery business for the year 1919. Each of these reports gives detailed statistics regarding expenses, profits, stock-turn, and ratios for a few items on the balance sheets of the stores. Similar summaries are to be prepared for the retail jewelry trade, for department stores, and probably for several other trades for the year 1920. The Bureau also is continuing its compilation of comparative prices for staple cotton cloth in the United States, England, India, China, and Japan. The reports for December and January, for example, indicated that at current rates of exchange, prices of staple cotton goods were lower in the United States than in any of these foreign countries. The Bureau plans to add price comparisons for several other markets as soon as reliable price quotations are available.

An Employment Service Study.—A study of public employment in the United States has been undertaken by the Russell Sage Foundation. The general purpose is to gather the experience of this country in planning, organizing, and administering public employment work. The work undertaken groups itself into three main parts. The first part includes the questions which have to do with the general organization and administration of the service. They include, among others, questions as to federal, federal-state, or some other unit of administration; the organization and function of the service from the federal center to the local ends; the status of the service in the federal, state, or local government organization; and the distribution of offices. The second part relates to the administration of the local offices, and the technique of the local service. This includes office layout; the placement process; practice in receiving, registering, interviewing, and referring applicants; forms and blanks in use; and so on. The third part covers the questions regarding the place and function of the service in our industrial life, local and national—what the obstacles are which the public employment service must meet and overcome if it is to have a healthy and reasonably rapid development, etc. The investigations have been made by Mary La-Dame, Leslie E. Woodcock, J. B. Buell, Fred A. King, and Helen B. Russell, nearly all of whom have been employed at one time or another in public or private employment work. Their experience has been gathered in several different sections of the country. The study is under the general direction of Shelby M. Harrison.

New Commerce Classification. The new schedules for the classification of imports and exports of the United States, which it was originally hoped might be inaugurated at the beginning of this calendar year, can hardly be put into effect for another year. The Department of Commerce has been unable to obtain hearings on the bill for the consolidation of the statistical divisions of the Bureau of Foreign and Domestic Commerce and the Customs Division of the Treasury Department, and consequently no additional appropriation for the new classification is yet available. The long delay in securing the hearings has been due to the fact that the bill in which provision for the new classification is incorporated was reintroduced in December as new legislation, and thus had to be referred to the Commerce Committee. When that Committee has approved suggested consolidation of offices, the bill will have to go before the Appropriations Committee for the consideration of the additional funds required to put the classification into effect. There appears to be no prospect of early action. Furthermore, it will be practically impossible to introduce the new schedules this year even if Congress should grant the necessary appropriations during the present session.

Child Labor Turnover. Of special interest to statistical students is the report on child labor recently published by the Children's Bureau.[*] The methods of analysis familiar in the construction of life tables are applied in this study to the registration statistics of child labor—the granting of employment certificates. A cohort of children born in a single year is followed from the fourteenth birthday, and the increasing proportion of children seeking employment is shown month by month until the sixteenth birthday is reached. Unemployment is studied in a similar manner. The decrease in the rate of new cases of unemployment is brought out month by month as the children's industrial experience lengthens, and the duration of these periods of unemployment is measured. Incidentally, it might be pointed out that this method of analysis of unemployment offers great possibilities in its application to unemployment among adults.

Legitimate and Illegitimate Birth-Rates. A comparative statement of legitimate and illegitimate birth-rates for the principal countries for the period 1907–1914 is given in a recent bulletin published by the Children's Bureau.[†] The report contains also comparative material as far as available for the various states and cities in the United States, compiled from state reports on vital statistics or from original data. An estimate of 32,400 illegitimate white births for the United States is given for the year 1915, an estimate which may be fairly considered as a minimum statement, in view of the incompleteness of the birth registration and the erroneous registration of illegitimate as legitimate births.

[*] *Industrial Instability of Child Workers. A study of employment-certificate records in Connecticut.* By Robert Morse Woodbury.

[†] *Illegitimacy as a Child Welfare Problem: Part I. A brief treatment of the prevalence and significance f birth out of wedlock, the child's status, and the state's responsibility for care and protection.* By Emma C. Lundberg and Katharine F. Lenroot.

Local Section of the Statistical Association Established in Pittsburgh. Through the efforts of Professor Donald M. Marvin, head of the Department of Statistics at the University of Pittsburgh, a local section of the American Statistical Association has been organized at Pittsburgh. The local members have elected the following officers: President, Roswell Johnson, School of Mines, University of Pittsburgh; Vice-President, Earl F. Evans, The Graphic Service Company; Secretary-Treasurer, Donald M. Marvin; Counsellors, J. Freeman Guy, Statistician of the Board of Education, S. L. Nicholson, Statistician of the Westinghouse Electric Company.

The death of Signor Luigi Bodio, one of the world's most distinguished statisticians and economists, occurred in Rome on November 2, 1920, within three weeks after his eightieth birthday. Signor Bodio, a senator of the Kingdom of Italy, was president of the International Statistical Institute. He was also honorary sectional president of the Council of State, president of the Superior Council of Statistics, president of the Council of Emigration and member of the Royal Academy "dei Lincei," vice-president of the Italian Geographical Society, Correspondent of the Institute of France (Academie des Sciences Morales et Politiques), Associate of the Statistical Society of Paris, Honorary Fellow of the Royal Statistical Society of London, Honorary Member of the Geographical and Statistical Society of Frankfurt, of the Statistical Society of Berne, of the Statistical Society of Manchester, and of the American Statistical Association. He was also a member of the International Colonial Institute of Brussels. He was a foundation member of the International Statistical Institute which was established in London, England, on the occasion of the Jubilee of the Royal Statistical Society in 1885. He became, in fact, first Secretary General of the Institute at the time when he held the office of Director General of the Statistics of the Kingdom of Italy, his election to this office being especially appropriate in view of the fact that the first meeting of the Institute was held at Rome in 1887. He held the office of Secretary General until the London Meeting of 1905, when, on his resignation, he was elected Honorary Secretary General. After the death, on November 28, 1908, of the President of the Institute, Dr. Karl Theodor Von Inama-Sternegg, at the meeting of the General Assembly at the Paris meeting on July 10, 1909, Signor Bodio was unanimously elected president of the Institute, the late M. E. Levasseur having declined that honor. During the course of his membership of the Institute, Signor Bodio attended all the thirteen meetings of the Institute with two exceptions, and he contributed to the proceedings a large number of reports and papers on statistical subjects, including especially studies relating to statistics of criminality and emigration. He was also associated with the late M. E. Levasseur in his important studies relating to the area and population of the countries of the world. His last public appearance in his capacity as president of the Institute was at the 13th Session held at Vienna, September 9–13, 1913, when the Permanent Office of the Institute was formed, in the direction of which as president he took a leading part. Signor Bodio was a member of the Commission on Statistics set up in 1920 to advise a policy for the League of Nations, and acted as chairman at the meetings of the Commission held at Paris in October, 1920.

Mr. R. H. Coats, Dominion statistician for Canada, returned in November from the meeting held at Paris, October 11–15, of the Commission appointed by the Council of the League of Nations to consider the organization of an international system of statistics under the League. While in Europe, Mr. Coats also attended the meeting of the Governing Body of the International Labor Office, at Geneva, October 5–7, as the representative of Canada. Mr. Coats was the member for Canada of the British Empire Statistical Conference which sat in London for six weeks during the winter of 1920 (January 20 to February 26, 1920).

The University of Oxford has awarded the Weldon Medal and the Weldon Memorial Prize to Dr. J. Arthur Harris of the Station for Experimental Evolution of the Carnegie Institution of Washington in recognition of his work in statistical biology. This prize may be awarded every third year ". . . without regard to nationality, sex, or membership of any university, to the person who, in the judgment of the electors, has, in the six years next preceding the date of the award, published the most noteworthy contribution to Biometric Science, in which either (i) exact statistical methods have been applied to some problem of Biology, or (ii) statistical theory has been extended in a direction which increases its applicability to problems of Biology. Biology shall, for the purposes of this clause, be interpreted as including Zoölogy, Botany, Anthropology, Sociology, Psychology, and Medical Science."

Professor Raymond Pearl, head of the Department of Biometry and Vital Statistics and director of the School of Hygiene and Public Health of the Johns Hopkins University, has been awarded the decoration of Knight of the Crown of Italy by the King of Italy. Beginning December 1, Professor Pearl gave a series of lectures at the Lowell Institute in Boston on the "Biology of Death." These lectures will be published later in book form.

Mr. Paul W. Garrett, formerly connected with the American International Corporation, is now with the financial department of the *New York Evening Post*.

Mr. R. von Huhn has been appointed chief statistician of the Edison Storage Battery Company at West Orange, New Jersey.

Mr. Robert Henderson, formerly actuary for the Equitable Life Assurance Society of the United States, has been made second vice-president of the company.

The Committee on the Mathematical Analysis of Statistics of the National Research Council is working on a handbook on statistical methods which will soon be published. The committee consists of Doctors Rietz, Glover, Huntington, Kelly, Pearl, and Persons.

The United States Life Tables for 1890, 1901, 1910, and 1901–1910 are now in the press and probably will be available within the next three months.

Professor Donald M. Marvin, of the School of Economics of the University of Pittsburgh, has been made head of the new Department of Statistics established by the university. Professor Marvin is developing a laboratory for training in statistical methods and their application.

APPOINTMENTS ON COMMITTEES FOR 1921

At a meeting of the Board of Directors on January 22, 1921, in New York City, the following appointments were made:

Associate Editors: Edmund E. Day, Louis I. Dublin, Wesley C. Mitchell, Horace Secrist, Leo Wolman; Assistant Secretaries: E. A. Goldenweiser for Washington, Martin J. Shugrue for Boston; Library Committee: Edmund E. Day, Chairman, Roswell F. Phelps, Horace L. Wheeler; Finance Committee: George E. Roberts, Chairman, Carl Snyder, Robert E. Chaddock; Membership Committee: Arthur R. Burnet, Chairman, Leonard P. Ayres, Earle Clark, Lawrence K. Frank, Donald M. Marvin; Committee on Business and Production Indices: Malcolm C. Rorty, Chairman, Leonard P. Ayres, Donald R. Belcher, Earle Clark, Edith M. Miller, Warren M. Persons, Carl Snyder.

In addition to these Committees the Board authorized the formation of three new committees as follows: Committee on Institutional Statistics, Committee on Statistics of Marriage and the Family, Committee on Sales Research. The personnel of these committees will be announced in the June issue.

NEW MEMBERS ELECTED SINCE AUGUST

Corporate Membership

Russell Sage Foundation, 130 E. 22nd St., New York City.

Regular Membership

Armstrong, George W., care of Sommons-Boardman Pub. Co., 2201 Woolworth Bldg., New York. Market analysis of railroad purchases.

Beauregard, Joseph E., Narragansett Electric Lighting Co., Providence, R. I. Statistician.

Begen, Owen J., Investment Department, Prudential Ins. Co., Newark, N. J.

Blanchard, Ralph H., School of Business, Columbia University, New York.

Buchaca, Emilio J., Manager, Commercial Research Department, H. H. Franklin Mfg. Co., Rochester, N. Y.

Burger, Magdalen H., Chief Statistician, Baltimore Alliance of Charitable Agencies, 625 St. Paul St., Baltimore, Md.

Cockett, Arthur, Famous Players-Lasky Corp., 485 Fifth Ave., New York.

Cox, Mary de, Librarian, American Tel. & Tel. Co., 195 Broadway, New York.

Creel, H. G., Southwestern Advertising Co., Oklahoma City, Okla.

De Maris, William F., Cost and Sales Department, New England Confectionery Co., 253 Summer St., Boston, Mass.

Fischer, Harry S., Public Service Commission, 49 Lafayette St., New York City.

Fisher, Arne, Statistical Department, Western Union Co., 195 Broadway, New York.

Florence, P. Sargant, U. S. Public Health Service, Washington, D. C.

Freeland, W. E., Sales Engineer, Winchester Repeating Arms Co., New Haven, Conn.

Fry, C. Luther, Industrial Bureau, Merchants Association of New York, 233 Broadway, New York.

Gottlieb, Louis R., Director, Subscribers Inquiry Department, Financial Weekly, 58 W. 39th St., New York.

Gould, Kenneth M., Editor, Social Hygiene, American Social Hygiene Association, 105 W. 40th St., New York.

Greenwood, Ernest, International Labor Office, 618 17th St., Washington, D. C.

Hammond, C. B., Research Department, Acme Wire Co., New Haven, Conn.

Heeren, Ernst G., Statistical Department, Edison Storage Battery Co., West Orange, N. J.

Helburn, J. W., Helburn-Thompson Co., Salem, Mass.

Janow, Barney, Chief Accountant, Nat'l Cloak & Suit Co., 207 W. 24th St., New York.

Jones, Charles E., Installation of Graphic Methods, Ernst & Ernst, 27 Cedar St., New York.

Kaufman, Elmer E., Agricultural Statistician, California Bureau of Crop Estimates, 508 Custom House, San Francisco, Calif.

Kester, Roy B., Department of Accounting, School of Business, Columbia University, New York.

Kucera, Joseph A., President, National Process Co. Inc., 117 E. 24 St., New York.

Lauck, William Jett, Economist, 712 Southern Bldg., Washington, D. C.

Lemon, Freda, Head of Statistical Department, Warner Sugar Refining Co., 79 Wall St., New York.

Masseck, C. J., Director of Sales, The Capper Publications, Topeka, Kans.

Melville, Andrew H., Director of Research, Nast Publications, 19 W. 44th St., New York.

Meyerson, Hyman, Statistician, Bureau of Statistics, Labor Department, Capitol, Albany, N. Y.

Miller, Elliott S., Famous Players-Lasky Corp., 485 Fifth Ave., New York.

Morse, Lawrence P., Director of Research, Babson's Statistical Organization, Wellesley Hills, Mass.

Odell, Frank G., Director of Research, The Capper Publications, Topeka, Kans.

Patton, Eugene B., Chief Statistician, State Industrial Commission, Albany, N. Y.

Perlman, Jacob, Statistician, Bureau of Statistics, Labor Department, Albany, N. Y.

Schutt, Kate M., Federal Reserve Bank, New York.

Smith, Charles Gordon, in charge of Workmen's Compensation Bureau, New York State Insurance Department, 165 Broadway, New York.

Thomas, Arthur C., Publicity Director, Chamber of Commerce, Omaha, Neb.

Wells, Alton L., President, American Institute of Medicine, 13 E. 47th St., New York.

Williams, Faith M., Division of Analysis and Research, Federal Reserve Board, 37 Liberty St., New York.

REVIEWS

Mental Aspects of Delinquency. By Truman Lee Kelly. University of Texas, Bulletin No. 1713, March 1, 1917.

This bulletin contains a scientific study of 296 boys who have been committed to the State Juvenile Training School at Gatesville, Texas. The ages of the delinquents studied vary in general from 10 to 19 years. The anthropometric data obtained relate to the height, weight, lung capacity, head measurements, scars on the head, and the stage of pubertal development. The sensory-motor data secured relate to the strength of vision, astigmatism, acuteness of hearing, disease or malformation of nose and throat, strength of grip, handedness, and speed of tapping. The mental data collected were secured by the Binet test, construction ability test, and the completion test. By combining the results of these three tests the developmental age of each boy was ascertained. The school grade reached by each boy was also considered in measuring his mental status. The distribution curve (normal probability curve) for the Gatesville boys has been superimposed upon a corresponding curve for normal boys in all the measurements where standard norms were available. The medians for delinquent boys are compared graphically with corresponding medians for normal boys, the per cent of delinquent boys above or below the median for normal boys being indicated on each diagram.

When the anthropometric measurements of Gatesville boys are compared with those of normal boys, it is shown that 52 per cent of the delinquent boys are above the median for the height of normal boys. The Gatesville boys also excel normal boys in weight, almost 64 per cent of these delinquents falling above the normal median. In vital capacity also these delinquents excel normal boys, over 59 per cent having a greater lung capacity than the median for the normal boy. With reference to pubertal development, the author finds that the Gatesville boys are inferior to normal boys, only 23 per cent having reached the stage of development attained by the median normal boy of equivalent age. The author finds a close agreement between pubertal and mental retardation, although no coefficients of correlation have been computed. In sensory-motor tests the delinquent boys were found to be inferior to normal boys, but in the following points they were above the median normal boy:

Grip of right hand	40 per cent
Speed of tapping	38 per cent

Unfortunately, no data for normal children were available with which to compare such physical defects as strength of vision, degree of astigmatism, acuteness of hearing, and defects of nose and throat. It was found that 37 per cent of the boys had defective vision and that in most cases it had gone both "undetected and uncorrected." The author states that "eye strain, school failure, truancy, and delinquency represent the history of nearly all of this 37 per cent" and suggests that defective vision may be partly responsible for juvenile delinquency. The author believes that children's eyes should be examined and that glasses should be provided at public expense as a preventive for much delinquency. With regard to hearing, only 10 per cent of the Gatesville boys were found to be defective.

The mental status of delinquent boys was found to be greatly inferior to that of normal boys. The following percentages show the proportion of such boys reaching or excelling the mental status of the median normal boy:

Binet test	21 per cent
Construction ability test	18 per cent
Completion test	7 per cent
Developmental age (average of three preceding tests)	10 per cent

The author does not consider the Binet test (a test of perceptual ability) to be very reliable since it does not apply to those delinquents whose mental development is above that of a normal child 12 years of age. The constructive ability test (by Kelley) consists in constructing some object out of material supplied by the examiner. The boy must decide upon the object to be made and construct it in accordance with the building material at his disposal. To score high on this test the boy must possess ability in inductive reasoning. Success in this test is not incident to school training. In the case of the completion test each inmate was asked to fill blanks in sentences—in short, to select such words as would make good sense and complete the sentence. In this test the problem has been definitely set, but the solution of it depends largely upon the boy's education and his lingual ability. These three tests, therefore, measure the perceptual, the reasoning, and the verbal ability of the boys. A combination of the three tests forms, therefore, a very reliable index of the boy's mental ability in comparison with that of normal boys. In general, as shown above, only 10 per cent of the delinquent boys are mentally equal to the "average" normal boy of equivalent age.

When the Gatesville boys are compared with boys in the Salt Lake City schools, they are found to have made relatively little school progress. Less than one per cent of these delinquent boys have reached the school grade attained by the average boy of the same age in Salt Lake City. It is quite apparent that these juvenile delinquents do not have the educational equipment possessed by normal boys. The author attributes a part of this deficiency to the fact that Texas had no compulsory attendance law until 1916, and consequently these juvenile offenders were not kept in school. It is rather unfortunate that the author should have compared the educational status of boys chosen from both rural and urban communities with that of normal boys living wholly in the city. The unreliability of the comparison is practically established when it is recalled that Texas boys had not been required to attend school, while the boys in Salt Lake City had been compelled to attend school regularly. Why such a norm should be selected, when an age-grade census for the whole State of Texas was available in 1916, is scarcely explainable.

Expressing the percentile relationships for the various measurements in terms of years of acceleration, it is found that the average Gatesville boy in height is 0.11 years in advance of the normal boy; in weight, 0.42 years in advance; and in vital capacity 0.66 years in advance. For all other measurements made, the average delinquent boy is retarded more than the normal boy by the following amounts: In grip of right hand, 0.45 years; in grip of left hand 0.42 years; in rate of tapping, 1.39 years; in Binet age, 2.18 years; in construction ability, 5.91 years; in completion test ability, 4.43 years; in developmental age, 3.65 years; and in school grade, 4.58 years.

The author has practically established his contention that "mental immaturity coupled with maturity in other lines, physiological, emotional— *i. e.*, development of likes and dislikes, sensitivity to ridicule, success, failure, etc.—gives the groundwork for misconduct," since, in general, delinquent boys are above the average in physiological development but considerably below the normal boy in mental attainment.

Although the complete history of each boy was not known, yet the author attributes delinquency largely to heredity. He asserts that "poverty and neglect pave the way toward delinquency and that low mentality starts the boy down it and keeps him on it."

It is shown that 25 per cent of the boys in the training school are feeble-minded, if feeble-mindedness be defined as consisting of those who are possessed of a mental age below 12 and are four or more years retarded as determined by the Binet test. The author recommends that a state board be established, such board to consist of a specialist in psychology and education, a physician and alienist, and a vocational director, who would decide upon the kind of education that the juvenile offender should receive and the kind of work in which he should engage after being paroled or dismissed from the reformatory, and also to determine who should be considered delinquent and who feeble-minded or insane. This board would have sole authority to determine fitness for pardon, parole, or final release from the state institutions. The court is qualified only to pass judgment as to whether an offender should be removed from society at large—not to determine degrees of mental ability or inability, nor to prescribe proper treatment therefor. The author also suggests that the period of commitment to the juvenile training school be made indeterminate in every case, so as to insure society from the further depredations of those delinquents who are unable to look after themselves with prudence enough to keep out of trouble, or who have not received sufficient training to enable them to become self-supporting individuals.

The graphic work in the study should have been more carefully planned and executed. The normal probability curves for normal and delinquent boys are mere skeleton outlines with no scale for either the ordinate or the abscissa axis. These curves permit of only one comparison—the percentage of delinquent boys above the median normal boy. It is very difficult to ascertain the method employed in determining the vertical scale for the percentile charts in which the standing of Gatesville boys is compared with that of the normal boy. The percentiles have not been equally spaced, thereby tending to exaggerate the relative positions denoting extreme excellencies and deficiencies. The result gives an erroneous notion as to the mental ability of Gatesville boys. This graphic presentation does great injustice to positions far away from the median or 50 percentile line. In fact, the diagram is rather a cartogram or pictogram than a graph possessing mathematical properties.

Another error in method should be pointed out. An attempt has been made to secure index numbers for pubertal development for the various ages by averaging directly the index numbers for 1,317 country boys with those for 3,600 city boys. No account has been taken of the fact that almost three times as many city boys as country boys enter into the make-up of the final averages with which Gatesville boys are compared. The results, however, are not materially affected by this error in computation.

The author inveighs against a lack of coöperation between the home, the school, the juvenile court, the reformatory, and the penitentiary. At present each assumes a shifting responsibility, each passing the problem of delinquency along to the next organization for correction. No records have been kept of individual boys to show conditions which may have caused or contributed to delinquency. The author has prepared five blanks on which valuable information should be recorded. He fails, however, to suggest the proper machinery for carrying his plans into effect. There is no assurance that society will have kept a record of all future Gatesville boys to such an extent that causal relationships may be traced and delinquency diagnosed.

The author recommends that the superintendent of the training school be chosen primarily because of his fitness as an educator and disciplinarian, and secondarily for his ability as a business man and a farmer, and that he should have a long tenure of office. As long as the superintendency is subject to political consideration, just so long will it be impossible for the superintendent to know the history of his boys, to appreciate their aspirations, and to be sympathetically concerned about their future welfare. Above all others, the delinquent boy needs some one who takes a paternal interest in him—one to whom he can look for fairness and intelligent guidance.

H. R. Bonner.

U. S. Bureau of Education.

Profits, Wages and Prices. By David Friday. New York, Harcourt, Brace & Howe, 1920. Pp. v, 256.

This little book, with its fresh and concrete treatment of questions which interest every one, is enjoying a well-deserved popularity. Statisticians have a special reason for reading it, for Professor Friday cultivates that quantitative type of economic theory for whose development they hope.

Several years ago Professor Friday began to use his connection with a firm of public accountants to study the profits of business enterprises with special reference to corporate savings. When the United States entered the war, he put his results at the disposal of the Treasury. Presently he was asked to enlarge the scope of his inquiries and to estimate how much the country could pay in taxes and how many billions it could lend in government bonds. In working for the Treasury, Professor Friday had access to all the relevant data in possession of the government bureaus, and opportunity to have his estimates criticised by the best informed men in financial circles, official and private. After the armistice, he returned to the University of Michigan and had leisure to combine with his own materials the information at every one's disposal. As a result of these varied experiences, he doubtless knows more than any one else about certain aspects of the economic history of the United States during the war.

The topics which he discusses in this book include the fluctuations of profits, interest, and wages during the war, the revolution in prices, the financial plight of public utilities, and the desirability of maintaining income and excess profits taxes at their present high levels. Instead of attempting to digest his conclusions on all these topics, I shall merely give a sample or two to show the kind of results at which he arrives. The first sample shows how that familiar fiction of economic theory, the normal rate of profits, is transformed when squarely faced by a statistician.

> "The most that can be said for the normality of profits is that the amount of capital that earns the average rate of profits will remain a fairly constant percentage of all capital. Also, that the amount of capital that earns less than the average rate or more than the average remains about the same one year with another. But the average itself is highly variable and the diversity of earnings for individual establishments is enormous even in so conservative and steady a business as banking" (p. 45).

The next quotations give certain interesting quantitative conclusions.

> "It is no exaggeration to say that not more than one-fourth, and probably not more than one-fifth, of the whole volume of corporate profits was actually spent by the stockholders of these concerns. The other 80 per cent went for taxes, for loans to finance the war, and to furnish the funds for industrial expansion" (p. 68).

DISTRIBUTION OF VALUE ADDED BY MINING, MANUFACTURING, RAILROAD, AND PUBLIC UTILITY CORPORATIONS

1913–1918

(In Percentages)

Year	Total value added	Wages	Taxes	Interest	Dividends	Surplus less deficit
1913	100.0%	63.9%	3.8%	8.9%	18.5%	4.9%
1916	100.0	56.6	4.0	6.0	14.3	19.1
1917	100.0	54.3	11.5	3.8	15.0	13.4
1918	100.0	61.0	13.7	5.4	11.7	8.2
1919	100.0	70.2	9.0	5.0	11.1	4.7

"These figures, without doubt, show pretty accurately the division of the product of these industries and the tendency of the respective shares of labor, capital and the state to increase or decrease" (p. 124).

Practically the most important and statistically the most doubtful of Professor Friday's conclusions concerns the "enormous increase of production over consumption" (p. 91) which he says "made possible" our "feats of war finance." From his belief in this increase he derives the optimistic view ". . . that we have such a reserve of productive capacity in this country that the possibility of raising the real wages of labor to the point where the means of well-being shall be realized for all classes remains no longer a mere dream. It has become a possibility" (p. 235). To realize this possibility he makes a practical suggestion which promises to attain wide celebrity. National production is now kept down by the frequent occurrence of dull times.

"The fundamental reason why production is retarded when only low profits are in sight is that a situation which yields small profits is one in which the prices of products and those of cost goods are close together. . . .

"The factor that prevents a full realization of our productive capacities is this risk of loss. . . . It is pertinent, therefore, to inquire into the possibility of decreasing industrial risk through formal organization. . . . If it were possible to guarantee every entrepreneur at least his operating expenses, including depreciation, the risk of loss would be minimized.

"Such a guaranty could be made only by the government, for it alone can exercise the taxing power necessary to take from the more fortunate industries those fortuitous profits which are the obverse of the losses incident to the modern industrial process. . . ." (pp. 246–8).

I do not think the merit of this suggestion is seriously compromised by rejecting Professor Friday's view that the war caused an extraordinary increase of production. What statistical information we have regarding the physical volume of output during the war—such as the index number of the volume of raw materials produced in 1913–1918 (published in the Summary of the War Industries Board's *History of Prices During the War*), the index numbers of agricultural and mineral products, compiled by Professor E. E. Day for the *Review of Economic Statistics*, the various series made by Mr. Carl Snyder for the Federal Reserve Bank of New York, and the index of production presented by Professor W. W. Stewart before the recent meeting of the American Economic Association—all indicates that the increase in productivity during the war differs little if any from that characteristic of the piping times of peace. The true state of affairs, indeed, is suggested by Professor Friday himself in a different passage. On page 134 he says "1916 saw a material increase in productive output in this country" (just such an increase over 1914 as we expect to find between the output of a very dull and a highly prosperous year). "This was further augmented in 1917 [though by a narrow margin] and was pretty well maintained during 1918."

This point is not the only one in the book to which exception may be taken on statistical grounds, though the other points are less important. Even when we differ from Professor Friday, however, we remember with gratitude that he is writing the kind of economic theory that deals with facts, the kind that is definitely right or definitely wrong, the kind that is capable of cumulative development if the rest of us in criticising imitate his use of quantitative methods.

Wesley C. Mitchell.

New School for Social Research.

Trends of School Costs. By W. Randolph Burgess. New York, Russell Sage Foundation, Department of Education. 1920. Pp. 139.

Trends of School Costs undertakes an analysis of the trends of teachers' salaries and school-building costs in the United States from 1841 to 1920. Other elements of expenditure for public schools are given little attention on the ground that the items are scattered, and constitute, when combined, only about one-fifth of total school costs. Index numbers for the full period from 1841 to 1920 are developed for the weekly salaries of men teachers and women teachers, both in city and in country schools. An index number for building costs is obtained for the period 1913 to 1919. Teachers' salaries are compared with the cost of living and with the wages of laborers and artisans, and trends are computed for all the more important series. The conclusion is reached that the school budget of 1915 must be doubled in 1920 if pre-war standards of public school education are to be maintained.

The conclusion that school budgets must be greatly increased leads Mr. Burgess, in the final chapter, to consider possible sources of income for the support of public education. He points out that nearly four-fifths of current school revenues are derived from local taxation, and that two-thirds of local revenues are obtained from the general property tax. To meet the doubled school budgets now required, municipalities must do more than reapportion their current expenditures. Large additional revenues must be raised. Mr. Burgess expects such revenues to be obtained principally from increased taxes upon real estate. "The real estate tax is a sound method of taxation, and, in spite of large increases in the tax rate of recent years, there are no indications that the rate which real property can bear has been reached."

In arriving at this conclusion, Mr. Burgess is traveling from the problems of education far afield into difficult questions of public finance. Possibly his conclusions regarding prospective sources of enlarged city revenue are consequently not to be taken too seriously. Certainly there can be no adequate discussion of municipal resources without a careful examination of the possibilities of increased local revenues from new forms of business taxation. Furthermore, there are important possibilities in extensions of the principle of grants to towns and cities from state authorities. It will be surprising if the next few years fail to show an increasing tendency toward centralization of school administration, with an accompanying resort to partial state collection of funds and subsequent grants to local treasuries from state authorities. In view of these possibilities, it has hardly yet been demonstrated that city schools must be financed as largely as in the past from the proceeds of the general property tax.

In his analysis of the elements of school expenditure, Mr. Burgess is upon more solid ground. The first chapter of his book deals with the mounting costs of education in this country. It is pointed out that the amount now spent for public schools is nearly twelve times that spent in 1870, though the number of school children is only four times as great. Furthermore, it is observed that school costs are rising with a constantly increasing increment, the rate of increase in expenditures being slightly in excess of five per cent per annum.

The course of rising school costs is studied in the trend of teachers' salaries and building costs. The method of determining these trends is to be carefully noted. In practically all cases, Mr. Burgess accepts as the trend the line of regression obtained by correlating the variable with time, and in most cases the period of fit is the 75-year span from 1841 to 1915.*

Examination of the various trends obtained in this fashion raises a serious question of method. Nearly all of the series included in the study are series of money items: total school expenditures, weekly salaries of teachers, the cost of living, artisans' wages, the cost of building materials. All of these series are materially affected by changes in the general level of prices. As a consequence, the several series reflect unmistakably the price episodes which have marked the economic and financial history of the country since 1841. The period from 1841 to 1861 is altogether different from the period of paper money inaugurated with the first issue of greenbacks in 1862. The rapidly rising prices of the greenback period bring experiences quite unlike those of the years of declining prices from 1873 to 1896. Later, the rapidly rising prices of the period from 1897 to 1913 have far-reaching consequences which are magnified many-fold during the price revolution since 1914. Teachers' salaries and building costs, like all other pecuniary phenomena, have been fundamentally influenced by general price movements. The relations between teachers' salaries and the cost of living, between teachers' salaries and wages of laborers and artisans, are quite different in periods of rising and of falling prices. To undertake an analysis of the trend from 1841 to 1920, without explicit and careful consideration of the several distinct chapters of monetary experience included within these seventy-five years, seems to attempt broad generalization at the expense of accurate diagnosis. The study of trends would be much more valuable if it carefully recognized the differences of trend in the successive periods of general price history.

The many direct comparisons of the several series presented in the book are much more instructive. The differences between teachers' salaries in city and country are striking. The relation between teachers' salaries and the wages of laborers and artisans is highly significant. The comparative course of teachers' salaries and the cost of living discloses the basic fact that teachers' salaries have gained on the cost of living during periods of declining prices and have ordinarily lost ground during periods of rising prices. Comparison of teachers' salaries with the cost of living as well as with wages of laborers and artisans suggests essential relationships between the underlying tendencies of the price level and the *real* compensation of government employees. The subject will repay further investigation. Burgess' analysis makes an excellent beginning for those government employees engaged in the important work of public education.

Trends of School Costs contains a substantial body of interesting and valuable information. The index numbers for teachers' salaries are an excellent compilation, and the study of building costs throws strong light upon an important subject. Although further details regarding the original data and the methods by which they have been combined would seem desirable in some instances, there is no reason for questioning seriously any of the important series developed in the analysis. In general, the book seems more serviceable in particular parts than as a whole. Despite its title, it seems least valuable in its study of "trends." For the greater part, the trends are unconvincing because determined without regard to fundamental changes in the level of prices. Upon the other hand, the direct comparisons of the several series are most instructive and make the book a valuable contribution to the understanding of public school administration.

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* In computing the coefficients of regression and correlation, Ayres' shorter method is employed. See *Journal of Educational Research*, April and May, 1920. Where the trend of the series is curvilinear, no real fit is attempted; but the difference between the first and the last items is assumed to have accumulated geometrically and a compound interest curve is drawn between the two.

Edmund E. Day.

Eighty-First Annual Report of the Registrar General of Births, Deaths, and Marriages in England and Wales, 1918. Cmd. 608, London, 1920. Pp. 450.

The Registrar General's reports of births, deaths, and marriages for England and Wales set a standard that other countries might well follow, and the 1918 report is up to the usual high mark. This volume contains the usual tables, among which are tabulations of births, deaths, and marriages under various classifications and in addition, tables giving the estimated populations for different classes of people in the country, the balance of inward and outward passenger movement, and meteorological data. These last three tables are not so common as they should be in reports on vital statistics.

The part of the volume devoted to the discussion of special diseases has been increased by the addition of sections treating malaria, diphtheria, and croup, influenza, dysentery, tubercle of the peritoneum and intestines, encephalitis and cerebro-spinal fever.

The effect of the influenza epidemic on the death-rate is discussed, and death-rates have been computed excluding the excess deaths due to influenza. The conclusion arrived at is that except for the epidemic the general health of the people was if anything better than that of previous years.

Among the special discussions of interest is one on the effect of the war on the marriage rates for different parts of England and Wales. While the marriage rate for the whole country for the year 1918 is slightly lower than the average prior to the war, the rate for rural and residential counties shows considerable increase, due probably to the shifting of the population caused by the war.

The increase of male births over female births since the beginning of the war is shown in the following table which gives the number of male births per 1,000 female births for each quarter of the years 1914 to 1918.

	First quarter	Second quarter	Third quarter	Fourth quarter
1914	1,031	1,037	1,031	1,043
1915	1,031	1,042	1,044	1,043
1916	1,050	1,051	1,045	1,050
1917	1,042	1,042	1,043	1,049
1918	1,043	1,046	1,048	1,056

This table, taken with the fact that prior to the war the highest ratio was that of the year 1875 when the ratio was 1,043 male births to 1,000 female, shows that there has been a striking increase in masculinity among the births since the beginning of the war. The possibility that this may be due to the marked increase in marriages immediately following the beginning of the war is discussed and rejected.

One criticism that might well be made of the report is that no mention of still-births is to be found. It is unfortunate that an item as important as this should be omitted from the Registrar General's reports.

L. J. Reed.

Birth Statistics for the Birth Registration Area of the United States, 1918. Fourth Annual Report. Bureau of the Census. Washington, 1920. Pp. 312.

Since the appearance of the first annual report on birth statistics for the year 1915, these reports have been steadily enlarged until in the present report we have as fine a record of birth statistics as is published by any country. The registration area for the 1918 report contains 53 per cent of the population of the United States. Since no change was made in the registration area during 1918, the figures in the present volume cover the same area as those of the 1917 report. It is important to note that all tables given in the volume for 1917 are repeated for the year 1918; comparisons, therefore, can be made between the two years for all the material published for 1917. The 1918 report, however, contains much additional information, relating particularly to infant mortality rates and to still-births.

The new tables on infant mortality rates show urban and rural infant mortality rates, and seasonal infant mortality rates in total and for special diseases. The information in both of these tables is given for the registration area as a whole and for each registration state.

The tabulations of still-births are to be commended particularly. In these tables can be found information relating to sex, color, month of birth, birth order, age, and country of birth of father and of mother, for still-births in the registration area for 1918.

One further additional table contained in the 1918 volume is that showing the number of mothers having a specified number of children born with the average number living, and the per cent of mothers having specified numbers of children living by color, and for white mothers, by country of birth.

While it is not possible to present in a review of this kind many of the tabulated results of the report, it is perhaps worth while to note the trend of the birth-rate in the registration area. The report gives the following tabulation:

Year	Rate per 1,000 population	
	Births	Deaths
1915	24.9	14.0
1916	24.8	14.7
1917	24.6	14.1
1918	24.4	18.2

Taken as a whole the report is very complete and the Census Bureau is to be congratulated on its work.

L. J. Reed.

The Inequalities of Incomes. By Hugh Dalton, M.A. London, George Routledge & Sons, Ltd.; New York, E. P. Dutton & Company, 1920. Pp. 360.

Mr. Dalton has set himself the problem of inquiring into the causes of the extreme inequality of incomes which exists. A thorough examination of past theories of distribution leads him to the conclusion that none of them has really solved the problem, and few have even envisaged it as an actual distribution between persons. The constructive portion of his book is then divided into the part on "The Division of Incomes between Categories" and that on "The Division of Income between Persons." Income is defined in terms of economic welfare, which may best be measured in terms of money, provided that the part of money income which does not increase economic welfare (*i. e.* business expenses, taxes, and gifts) is excluded, and that a money equivalent for "real " income is added (p. 162 *et seq.*).

The division of income between its two chief sources, *i. e.*, ownership of property and the performance of work, is found to rest on the relative elasticities of demand and supply of these two items. He comes to the general conclusion in agreement, on the whole, with Pigou, that the absolute share of any factor of production, as a result of an increase in its supply, varies according as its elasticity of demand is greater or less than one; and that its relative share varies according as its elasticity of demand is greater or less than the reciprocal of the fraction expressing the total share of all the other factors of production. The application of these principles to the division of income between work and property, leads to the conclusion that as the supply of either increases, the absolute shares of each will increase. With regard to the relative division, he finds that the share of property is likely to increase in the future owing to the greater elasticity of supply of property. This portion of the work is highly suggestive, and the theoretical argument is presented with great skill. It is a pity that Mr. Dalton has not based his work on statistical material, or at least has not followed up his conclusions with statistical examples.

When we turn to the division of income between persons, there is clear evidence that this is the portion of the book on which the author has turned not only his brain but his heart. "The waste of potential human welfare, which great inequality involves, is the central idea upon which the various enquiries undertaken in this book are designed to converge" (p. 239).

Income from civil rights (old age pensions, war pensions, health and unemployment insurance, and the like) Mr. Dalton finds, on the whole, tend to equalize conditions of welfare. Such income-bearing civil rights, should therefore be encouraged.

The differences in income from work depend partly upon the amount of work done, and partly upon its value. Special agreements and legal enactments, limiting the hours of work or the conditions of competition, have an influence. Moreover, the freedom to choose a given occupation, which involves the ability to spend the requisite number of years in attaining a high degree of skill, also plays its part. But all of these differences are of relatively small importance, and subject easily to change by government.

It is when we come to the inequality which is due to the inheritance of property that we find the really important problem. Here the inequalities are far greater than in the incomes from work. "The phenomenon of inherited wealth is at once very curious, very important, and very much neglected" (p. 281).

The writer finds that this institution promotes social stratification, and that it is advancing at an ever accelerating pace. No longer is it true that there are three generations between shirt-sleeves and shirt-sleeves; indeed, "the rich by inheritance, have a position which they can lose only by a destructive tendency amounting almost to madness" (p. 283). Again it is unfortunate that Mr. Dalton does not reënforce his argument by a wider use of statistics. He next proceeds to discuss various schemes for the limitation of inheritances. Under this head, he gives enthusiastic support and approval to the original device propounded by Professor Rignano. This plan is to tax at an increasing rate that part of a fortune which passes through more than one generation, so that in a comparatively short time it will be wiped out altogether. Thus, a son would inherit two-thirds of his father's estate, but could pass on only a small portion of this sum. In order to leave a large bequest, he must earn money on his own account. He believes that the perplexities in connection with the practical application of this scheme—such as the separation of the property into that which is inherited, and that which is earned, and the reduction of gifts *inter vivos*—could be successfully solved.

Another little-known idea brought forward is that of Professor Pigou, that all inheritances should be settled on public trustees, who should control the property in the public interest and pay over the income to the beneficiary. Among the other reforms advocated are the abolition of primogeniture, a narrowing of the rights of relatives in the property of intestates, and the limitation of the amount of any individual inheritance.

If any criticism is to be offered of this spirited and scholarly treatise, it is that the groundwork is not sufficiently well laid. What are the amounts involved? How great are the inequalities of income? How many people would be adversely affected by the carrying out of the proposed reforms? To what extent would the community at large be benefited? With the exception of a few limitations (pp. 202, 207), a favorable answer to all these questions is assumed; and yet it can scarcely be said that the correct answers to them all are matters of common knowledge.

OSWALD W. KNAUTH.

National Bureau of Economic Research, New York.

Readings and Problems in Statistical Methods. By Horace Secrist, Ph.D. New York, The Macmillan Company, 1920. Pp. xi, 427.

In recent years books of readings have come to serve as valuable supplements to regular text-books in many courses of study. In perhaps no field has the instructor felt more the need for a well-selected book of readings than in the field of statistics. The limitation of space necessarily compels the author of a text-book on statistics to confine himself largely to a discussion of general principles and methods. The study of statistical principles, however, except perhaps as an exercise in logic or mathematics, serves no valuable purpose in itself; it is useful only as a means of furnishing a tool for the conduct or understanding of actual investigations of concrete problems. Consequently, every teacher of the subject has doubtless recognized the desirability of bringing to the attention of his students examples of the application of statistical methods in the analysis of practical problems. Satisfactory illustrative material, however, must be gathered from numerous sources, and if the instructor's class is large, or if its ready access to the material is not feasible, a severe handicap in instruction is experienced. A compact volume of readings, carefully chosen to show the use of statistical methods in actual investigations, would go far toward overcoming these difficulties.

Although it is the opinion of the reviewer that such a collection of readings would meet the greatest need, it is quite possible to arrange a collection with other purposes in view. For example, the selections might be chosen simply with the idea of amplifying the theoretical discussions of a text-book, or an attempt might be made to make the readings serve as a complete text in themselves, with perhaps the inclusion of certain selections for illustrative purposes. Compilers of books of readings may differ in their conceptions of the proper functions of such a book; but, whatever it may be, some well-defined purpose should exist in the compiler's mind and should be adhered to in his choice of readings. If an attempt is made to compile a collection which will serve several purposes at once, there is danger that no purpose will be adequately served.

In the introduction to Professor Secrist's volume, it is stated that selections were chosen "to illustrate concretely the attitude of mind in which statistical analysis must be undertaken and to develop logically the steps and processes through which statistical data must be carried in order to be used as bases for logical inferences." The selections are intended to constitute within themselves an independent treatment of statistical principles, but it is expected that they will have their greatest value when used in connection with a text on statistical methods and are intended primarily for use in this manner. Their use in connection with the compiler's own text-book, *An Introduction to Statistical Methods*, is considerably facilitated by the employment of the same chapter headings in both volumes. The readings include selections dealing with the usual subdivisions of statistical methods—the collection of data, classification and tabulation, diagrammatic presentation, averages, index numbers, summarization, and comparison. They are drawn from various sources such as government reports, special studies, statistical and economic journals.

In the choice of readings the volume suffers from the attempt to serve too many purposes. Doubtless the desire of the compiler to make the readings serviceable independently as a text led him to include many selections that are purely abstract discussions of statistical principles and their uses. But such selections are not inclusive enough or well enough coördinated to enable them to answer adequately the requirements of a general text. For instance, the chapter entitled "Description and Summarization—Dispersion and Skewness," contains nothing whatsoever explaining the various measures of dispersion and skewness. Similarly, the selection in the following chapter dealing with correlation would not be understandable to the beginner in the study of statistics without supplementary reading in a text. The book contains too many gaps in the exposition of the elements of statistical methods to make it in itself a satisfactory dependence for general text-book purposes.

As the compiler states, however, the readings are intended primarily for use in connection with a text on statistical methods, and it is the opinion of the reviewer that this is the only way in which they could be used satisfactorily. But if a text must be used along with the readings, it would seem that the space devoted to the abstract discussion of theory and methods could have been much reduced without loss to the student. This would be true, for example, of practically the entire chapter on tabular presentation, which is devoted to an exposition of general principles with no concrete illustrations. The omission of such selections would have made possible the inclusion of much more material illustrative of the practical application of statistical methods in actual investigations—a type of material which, as stated above, it is believed would fill the greatest need in the teaching of statistics. There are some excellent specimens of this type included in the *Readings*. For example, the one from Chaney and Hanna's *The Safety Movement in the Iron and Steel Industry, 1907 to 1917*, in connection with the study of units of measurement; also, several selections from Professor Davis R. Dewey's Report on "Employees and Wages" in the *Twelfth Census*. It is regrettable that more readings of this type were not substituted for some of the abstract discussions. In the introduction, the compiler states that his purpose has been to emphasize the use of statistics. But would the student not be much more impressed with the use of statistics in business, for instance, by a concrete example of the statistics actually collected and used by some business organization, than by a general discourse upon the subject?

It is believed that the serviceableness of the readings could have been greatly enhanced by thus placing greater emphasis upon the application of statistical methods in the choice of selections. Nevertheless, both the student and the instructor will find this volume a useful aid in the study of statistical methods. Through it ready access is provided to supplementary and illustrative material that for many would otherwise be unavailable. The value of the volume for pedagogical purposes is enhanced by the inclusion, at the end of each important article, of questions which should prove stimulative to the thinking of the student along collateral lines as well as suggestive of practical problems to which they may relate. Review problems at the end of all ten chapters except the first three provide material for the much needed exercises or laboratory work in connection with courses in statistical methods. The author is more or less apologetic for the inclusion of these problems, but unduly so; no instructor in statistics will begrudge them the few pages of space that they occupy and all, on the contrary, should welcome them as a valuable aid in teaching.

William O. Weyforth.

The Johns Hopkins University.

Workingmen's Standard of Living in Philadelphia. By William C. Beyer, Rebekah P. Davis, and Myra Thwing. New York, The Macmillan Company, 1919. Pp. x, 125.

Among the many attempts to measure living costs, this report of the Bureau of Municipal Research of Philadelphia must be awarded high rank. In 1917, the Bureau undertook to establish a living wage to serve as a basis for the payment of manual laborers in the employ of the city. Thoroughly alive to the fact that any estimate in terms of money would have but momentary value, the Bureau determined to derive such a "goods standard" that its money equivalent could be calculated at frequent intervals.

In arriving at the "goods standard," experts on diet, housing, and industrial relations were consulted, and the work of Chapin, of Cotton and Little, and of the War Labor Board was studied; but main reliance was placed upon a new investigation among self-supporting families of Philadelphia manual laborers whose principal bread-winner did not earn more than $2,000 a year. As usual, the attempt to induce families to keep accurate accounts met with little success. The best data were secured by skilful personal interviews based upon an elaborate schedule. The answers of each housewife were tabulated, and the estimated expenditures checked with the income. If there was a larger discrepancy between income and disbursements than five per cent, the schedule was rejected. Great emphasis was placed upon obtaining quantities of goods used as well as payments.

The conclusions are presented at length in the fourth chapter. The standard of living consists of (1) a two-story row house with six rooms, a bathroom, a laundry, a furnace, and gas for cooking and lighting; (2) five tons of coal, 26,000 cubic feet of gas, and fifty-two boxes of matches; (3) food in amounts specified for a family of five individuals with the consuming capacity of 3.80 adult males; (4) clothing, the articles needed by each member of the family being listed in detail; (5) car fares for 708 rides; (6) certain cleaning and toilet supplies; and (7) the unspecified standard. The lists in groups (1) to (6) are very detailed and complete. After their money cost has been determined, 21 per cent is added for group (7), comprising health, furnishings, taxes, recreation, education, insurance, and other miscellaneous items. In the fall of 1918, the money equivalent of this standard was $1,636.79.

The authors recommend that this goods standard be revised at least once in five years, and that its money equivalent be calculated annually in order to fix minimum wages for adult males in unskilled manual municipal employments. They suggest that similar standards be devised for other classes of workers.

Any estimate of a cost of living is an easy target for criticism as to minutia. It is hard to imagine, for example, a manual laborer's making a pair of hose supporters last for a whole year, or five twenty-five cent tooth-brushes' cleansing five sets of teeth 1,095 times apiece. On the other hand, the authors frankly recognize the difficulties in their way and show that each item is the result of careful study. They proclaim that the standard is based upon conditions in Philadelphia in 1918. They would be the first to admit that their standardized Philadelphia house hardly exists in Indianapolis or in New York, or that their annual dietary might be difficult of realization in New Orleans or in Bangor.

The working-out of a standard expressed in goods has long been the goal of persons interested in the cost of living. This book is a welcome contribution to the solution of the problem.

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Animal Foodstuffs, Their Production and Consumption with a Special Reference to the British Empire. By E. W. Shanahan. London, George Rutledge and Sons; New York, E. P. Dutton and Company, 1920. Pp. viii, 313.

If the professors of economics and political science in American universities wish to blush, the following recipe is recommended:

Select at random five doctors' dissertations in those fields, approved by each of ten American graduate schools, and compare them with E. W. Shanahan's thesis on *Animal Foodstuffs* presented for the degree of doctor of science in the University of London.

In the preface Dr. Shanahan says:

> "An attempt has been made in this inquiry to survey quite impartially the productive resources of all important parts of the world in respect of animal foodstuffs. This has involved a great deal of detailed research. Throughout this part, and indeed throughout the whole of the investigation, the close relationship between animal foodstuffs and concentrated feedstuffs has been insisted upon. The main conclusion drawn has been that the supplies of animal foodstuffs tend at present, and are still more likely in the near future, to be deficient.
>
> "This has led to an inquiry into the economic position of animal industries in agriculture, into their costs of production, and into the economics of consumption in relation to production in respect to them. All these have been studied in their bearing upon future movements. No distinct attempt, however, has been made to deal with the subject of marketing which arises in this connection since the field appeared too wide and the questions too complex and technical for adequate discussion."

The 318 pages of text are divided among Part I, Production—192 pages; Part II, Consumption—82 pages; and Part III, The Production and Consumption of Animal Foodstuffs in the British Empire—42 pages.

The author says that it is a study in economic geography and agricultural economics. His utilization of agricultural economics is excellent; and if his mastery of geography had been as thorough as his mastery of agricultural economics, the book would indeed have been a very great treasure. It is a treasure, nevertheless; but like most economists, he assumes that he can deal with geography without knowing much geography other than the locational variety. His apparent ignorance of the fundamental facts and factors of climate has caused a few slips and misappreciations in a book which shows a very careful and wide survey of the literature bearing upon the meat producing resources of the world.

The food supply has become a world problem, and the recurrence and utilization of this background fact in the book is most useful.

Dr. Shanahan's thesis is a valuable addition to my book-shelf.

J. Russell Smith.

Columbia University.

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THE COEFFICIENT OF CORRELATION

By Franz Boas, *Columbia University.*

Students who are using the coefficient of correlation are aware that the value of the coefficient does not always express the biological, psychological, social, or economic relations which are the subjects of our studies; they realize that its value depends upon a good many extraneous conditions. Since, however, in literature the coefficient is too often used in a mechanical way, and the results of study are generally interpreted as having an immediate bearing upon the problems at issue, without a detailed study of the composition of the series, it seems desirable to call attention to some of the conditions influencing its value.

When two variables are interdependent so that a variant of one partly determines the correlated array of the other, we express their relation by the coefficient of correlation. The derivation of this value is based on the assumption that the averages of arrays are proportional to the determining variant, each being measured from its own average, and on the further assumption that all arrays have equal variability. The former assumption is expressed by

(1*a*) $[y]=q_1x$, (brackets indicating averages)

and conversely by

(1*b*) $[x]=q_2y$.

From these we derive by multiplication

(2*a*) $[xy]=q_1[x^2]=q_1\sigma_x^2$

and

(2*b*) $[xy]=q_2[y^2]=q_2\sigma_y^2$.

It follows that

$$q_1\frac{\sigma_x}{\sigma_y}=q_2\frac{\sigma_y}{\sigma_x}$$

and we call this value r, the coefficient of correlation. Hence

$$r=\frac{[xy]}{\sigma_x\sigma_y}. \tag{3}$$

If we call the variability of an array of y around its own average s, then the mean square variation of the array around the average of the total series to which the array belongs will be

$$s_y^2+q_1x^2.$$

The total mean square variability of y, which is σ_y^2, must therefore equal

$$\sigma_y^2=s_y^2+q_1^2\sigma_x^2 \tag{4a}$$

$$\sigma_y^2=s_y^2+r^2\sigma_y^2, \text{ or} \tag{4b}$$

$$s_y^2=\sigma_y^2(1-r^2). \quad \text{In the same way} \tag{4c}$$

$$s_x^2=\sigma_x^2(1-r^2). \tag{4d}$$

In the series of these values, we are operating therefore with the following seven quantities, σ_x, σ_y, s_x, s_y, q_1, q_2, r.

There are certain relations between these quantities.

$$\left\{\begin{aligned} q_1q_2&=r^2\\ s_x^2&=\sigma_x^2(1-r^2)=\sigma_x^2-q_2^2\sigma_y^2\\ s_y^2&=\sigma_y^2(1-r^2)=\sigma_y^2-q_1^2\sigma_x^2\\ q_1\sigma_x^2&=q_2\sigma_y^2.\end{aligned}\right. \tag{5}$$

Since these four equations determine relations between these seven values, there are only three that are independent. The character of the problem to be investigated determines which among the seven values may be considered as independent factors. To give an example: When we investigate proportions of the body we may recognize that in a group of common descent individuals of a certain stature have a certain average weight which has a certain variability. The relation is a physiological and anatomical one, and the stature partly determines the weight. The three values, the relation of which determines the other values are, therefore, σ_x which expresses the range of stature of the individuals examined; s the variability of the independent array of weights; and q_2 the coefficient which determines the average weight as determined by stature. All the other values must be expressed in terms of these three.

$$\sigma_y^2=s_y^2+q_1^2\sigma_x^2$$

$$q_2=\frac{q_1\sigma_x{}^2}{s_y{}^2+q_1{}^2\sigma_x{}^2}$$

$$r=\frac{q_1\sigma_x}{\sqrt{s_y{}^2+q_1{}^2\sigma_x{}^2}}$$

$$r=\frac{1}{\sqrt{1+\frac{s_y{}^2}{q_1{}^2\sigma_x{}^2}}}. \tag{6}$$

If, for any reason, there is a selection of values of x, the coefficient of correlation will change its value, although the actual functional relation between x and y remains the same. In other words, in cases of this type, the coefficient of correlation is an artificial value, an algebraic convenience which depends upon the composition of the series. It follows from this that, for instance, in military statistics in which a selected group is examined, the coefficient of correlation for the selected group cannot coincide with the coefficient for the total series.

It must be remembered that in this case q_2 will no longer be constant, since the arrays are disturbed by the selection. The general theory, however, remains unchanged if we substitute in equation (2*b*)

$$[xy]=[q_2y^2]=q_2{}'\sigma_y{}^2$$

and utilize $q_2{}'$ in place of q_2. It will be seen that in this case the second assumption, namely, the equality of the variability of the arrays of y, does not hold good. If there is a selection with regard to both variables, as in military statistics, when individuals of underweight and of understature are eliminated, neither q_1 nor q_2 can be determined according to the method here discussed. We must substitute for equation (4*a*),

$$\sigma_y{}^2=[s_y{}^2]+[(q_1x)^2] \tag{7}$$

then equation (6) takes the form

$$r=\frac{1}{\sqrt{1+\frac{[s_y{}^2]}{[(q_1x)^2]}}}.$$

In these cases, the essential problem will be not the determination of r, but the determination of the two values of q.

If we had a selection in which only one end of the distribution were eliminated the problem could easily be solved. In most cases, however, the cutting off of one end will affect to a greater or lesser extent the adjoining part of the distribution curve. This may be seen clearly in the distribution of statures in the Italian army as given by Livi in his

Antropometria Militare. The lowest stature is 154 c., but those just above 154 c. are also reduced in numbers because individuals of low chest measurements and other deficiencies will be more common among those individuals whose stature is a little over 154 than among tall ones. It does not seem, therefore, worth while to carry through a detailed calculation of the general problem because the characteristics of the distribution will have to be investigated in each particular case.

The dependence of the coefficient of correlation upon the distribution of the variables appears particularly in cases of tetrachoric distributions of disparate forms. We assume two alternative pairs of forms: a with the probability of occurrence p_a, and *not* a with the probability of occurrence q_a; and b and *not* b with the respective probabilities of occurrence p_b and q_b. Among all the cases of occurrence of a, b combined with a has the probability f_{ab}; among all the cases of non-occurence of a, b combined with *not* a the probability f_{ob}. In the same way, among all the cases of occurrence of b, a combined with b has the probability f'_{ab}; among all the cases of non-occurrence of b, a combined with *not* b the probability f'_{oa}.

When in a particular series the form a appears p_a+x times, the form *not* a will appear q_a-x times. In such a group of series b will occur on the average

$$[p_b+y]=f_{ab}(p_a+x)+f_{ob}(q_a-x) \text{ times; and}$$

$$[y]=x(f_{ab}-f_{ob})=cx.$$

In the same way

$$[x]=y(f'_{ab}-f'_{oa})=c'y.$$

Hence

$$[xy]=c[x^2]=c'[y^2]$$

since

$$[x^2]=\frac{p_aq_a}{n},\quad [y^2]=\frac{p_bq_b}{n}$$

$$[xy]=c\frac{p_aq_a}{n}=c'\frac{p_bq_b}{n}$$

$$\frac{c}{n}=r\sqrt{\frac{p_bq_b}{p_aq_a}}$$

$$\frac{c'}{n}=r\sqrt{\frac{p_aq_a}{p_bq_b}}$$

$$r=\sqrt{\frac{[xy]}{p_aq_a\cdot p_bq_b}}.$$

In this case c and c' are quantities determined by the character of the series: p_a and p_b express the relative frequencies of the two types treated. It appears, therefore, that r is determined by these frequencies. To give an example: Given a large bag of black (np_a) and white (nq_a) pieces of cardboard; these pieces are in part round (np_b), in part square (nq_b); $np_a f_{ab}$ pieces are black and round; $nq_a f_{ob}$ are white and round; $np_b f'_{ab}$ are round and black; and $nq_b f'_{oa}$ are square and black. Then even if the values of f remain the same, the coefficient of correlation is determined by the frequencies p_a and p_b. It will be understood that the values of f are all interdependent. We may write

$$f_{ab}=p_b+\frac{\delta}{p_a}; \qquad f'_{ab}=p_a+\frac{\delta}{p_b}$$

$$f_{ob}=p_b-\frac{\delta}{q_a}; \qquad f'_{oa}=p_a-\frac{\delta}{q_b}.$$

Then, as is easily shown, for a series of n cases

$$\delta=[xy].$$

It is obvious that this proof holds good only in cases of alternative qualities. When we have a tetrachoric distribution based on an artificial division of a range of continuous variation, the values c and c' are not constant.

I may point out that the proof given here proves the correctness of my previous discussion of this subject (*Science*, N. S. Volume 29, 1909, pp. 823–824). It does not seem to me that the criticism of the theory made by Karl Pearson (*Science*, N. S. Volume 30, 1909, p. 23) and by Karl Pearson and David Heron (*Biometrika*, Vol. 9, 1913, p. 166 and Vol. 8, 1911, p. 114) is valid. This criticism was repeated later on by Arnold Lang (*Experimentelle Vererbungslehre in der Zoologie*, seit 1900, Erste Hälfte, Jena, 1914, p. 419) on the basis of Poniatowski's remarks. I have discussed this subject more fully in a general report on *Anthropometric Investigations of the Population of the United States.*

A second case in which the purely conventional meaning of the coefficient of correlation appears clearly is that of mixed series. I have treated this problem at another place* and it may be sufficient to repeat the general argument as applied to a particular case. If we have a mixed population of round-headed and long-headed individuals who may have intermarried, and among whom there is a tendency of reversion to parental types; if, furthermore, the long heads in this series are in absolute measures long and narrow, the round heads absolutely short and wide, then short heads will, on the whole, be wide, and long heads narrow, and we find a negative correlation; while in a homogeneous series there will be a positive correlation, because both absolute measures increase with absolute size of the head. In cases of this type, the coefficient of correlation is a valuable means of determining the composite character of the series. If the character of the homogeneous series is known, it may even enable us to determine the character of the composition, but it does not express the inner relation between two values.

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* "The Cephalic Index," *American Anthropologist*, N. S. 1: 448–461.

Correlations may thus merely be expressions of the variability of a series. At another place* I have demonstrated the relation between the coefficient of correlation expressing the similarity of brothers and the variability of family groups. For large fraternities or whole populations, this relation is easily demonstrated. If a number of fraternities or local units are distributed, each around its own average, and the averages themselves are distributed according to the laws of chance, we may call the deviation of the average of a particular population or fraternity from the general average x; that of an individual in each population or fraternity from its own average y. Then, the correlation will depend upon the products

$$(x+y)(x+y^1)$$

which have to be taken in each group. Since the individuals in each group are independent

$$[(x+y)(x+y^1)]=[x^2]=\sigma_x^2$$

and

$$r=\frac{\sigma^2{}_x}{\sigma_x{}^2+\sigma_y{}^2}.$$

In other words, the coefficient of correlation is determined by the variability of the averages of the separate groups and that of the individuals in each group.

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* "On the variety of Lines of Descent represented in a Population," *American Anthropologist*, N. S. 18: 1–9.

NATIONAL CHANGES IN HEALTH AND LONGEVITY*

BY ARTHUR NEWSHOLME

The subject roughly indicated in the title as announced evidently cannot be even outlined in an hour's address; my remarks will deal chiefly with some of the changes in longevity in England and, so far as they are ascertainable, in this country. After a more general introduction, I propose to confine my review to men, merely indicating that improvements in the male have in nearly every instance been exceeded in the female sex. As will be seen shortly, I propose, furthermore, to limit my comparisons chiefly to the period beyond the 40th year of human life.

It will be agreed that the object of preventive medicine is to secure long life with enhanced health. The mere desire for long life may, from a certain angle, be regarded as including some ignoble elements. There is a sense in which we must agree with the Wisdom of Solomon:

> "Honorable age is not that which standeth in length of time, nor is measured by number of years. He being made perfect in a short time fulfilled a long time."

Although it is the desire of every man to die of old age, there are many passions more powerful. As Lord Bacon said:

> "There is no passion in the mind of man so weak, but it mates and masters the fear of death. . . . Revenge triumphs over death; love slights it; honor aspires to it; grief flyeth to it; fear pre-occupateth it."

But to die of old age is the laudable ambition of all. We may assume that death is a normal, though the last, act of life. In Goethe's words, "Life is the most exquisite invention of nature, and death is her expert contrivance to get plenty of life."

To die of age is comparatively rare. Disease and accident, in times of peace, are the chief causes of death in civilized communities; premature and therefore wasteful death is the rule among us. This is illustrated by the following table, which shows in various life-table experiences the age at which a given number (say 100,000) starting at birth becomes reduced to half its original size (say 50,000).

It is convenient here to explain for the benefit of non-technical readers that a life table represents "a generation of individuals passing through time." Theoretically, it may be formed by actually watching a large group of persons from birth to death, and ascertaining the number of survivors and the average future expectation of life at each successive birthday. But such a life table would be obsolete before it could be utilized; and in the life-table figures quoted hereafter, the death rates for each age-period of life during a short series of years are assumed to determine the number of survivors to the next age-period, who are then subject to the death rate of the next age-period in the same years, and so on.

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*A lecture delivered before the Harvey Society, Jan. 29, 1921.

TABLE I

AGE AT WHICH POPULATION IS REDUCED TO ONE-HALF POPULATION AT BIRTH (LIFE-TABLE EXPERIENCE)

	Experience of	Males	Females
England and Wales	1901–10	58–59 years	62–63 years
" " "	1909–11	61–62 "	65–66 "
United States of America:			
Experience of	1909–11		
Entire population	Original registration states	58–59 years	62–63 years
White	"	59–60 "	63–64 "
Negro	"	34–35 "	40–41 "
Native white	"	60–61 "	64–65 "
White in cities	"	55–56 "	60–61 "
White, rural	"	65–66 "	67–68 "
Indiana		64–65 "	66–67 "
Massachusetts		58–59 "	62–63 "
Michigan		64–65 "	66–67 "
New Jersey		57–58 "	62–63 "
New York		55–56 "	61–62 "

Dr. Farr (35th Ann. Rep. of Reg. General) described the age between 45 and 55 as the middle arch of life, since shortly after the 45th year of age, a million born at the same time were reduced to half a million. Now a much larger proportion pass this middle arch of life.

In most of the communities mentioned, half of the total population born has scarcely disappeared before reaching the 60th annual turnstile.

This is true for a life-table population in which a given number of persons are traced through life on a fixed basis of experience. In actual life there is in most communities a greater stream of incoming

TABLE II

ENGLAND AND WALES, 1901–10

PROPORTION OF DEATHS AT ALL AGES (=100) AT DIFFERENT AGE-PERIODS

Age	Males		Females	
First 5 years	35.0		31.0	
Twenty years 5–25	7.8		8.3	
" " 25–45	12.6		12.2	
" " 45–65	20.8	44.6	19.1	48.5
Ages 65 and upwards	23.8		29.4	
	100.0		100.0	

new lives by birth than of departing lives; the loss of life under these circumstances is heaviest in the earlier years of life. This is illustrated in Table II, which gives the proportion of deaths at all ages that occurred at different age-periods in England and Wales during the years 1901–10.

Thus, in actual experience only 44.6 per cent of the male and 48.5 per cent of the female deaths occur at ages over 45.

THE VITAL SUPERIORITY OF THE FEMALE

It will be noted that a smaller proportion of female than of male deaths occur in early life; also that on the average females live longer than males. The following table shows that at every age except the age between 5 and 15, the female death rate is lower than that of the male at corresponding ages.

TABLE III

PERCENTAGE EXCESS OF MALE OVER FEMALE DEATH RATE AT EACH AGE-PERIOD DURING TWO DECENNIA*

Age	1851–60	1901–10
0–	+15	+19
5–	+1	*−3*
10–	*−3*	*−5*
15–	*−9*	+7
20–	+4	+19
25–	*−4*	+17
35–	+3	+22
45–	+18	+30
55–	+14	+28
65–	+11	+20
75 and upwards	+6	+12

* This table and most of the other tables given in this paper are derived from Dr. Stevenson's contributions to the Reports of the Registrar General of England and Wales.

The death rate at every age in both sexes has declined, but males show an increasing excess of mortality as compared with females, amounting to a maximum excess of 30 per cent at the age-period of 45–55. The excess of female over male mortality at ages 5–15 in 1901–10 and at ages 10–15, which has held good during seven consecutive decennial periods of English experience, would form an admirable subject for further study. Except at these ages the superiority of female over male vitality is evident throughout life—a fact which is perhaps too little known.

In England and Wales, for every 1,000 live-births of female infants there were 1,049 live-births of male infants in 1841–50, the proportion slowly falling to 1,038 in 1901–10, and rising again to 1,045 to every 1,000 female births in the three years 1916–18.

In the birth registration area of the United States in 1918 the proportion of male to female live-births was 1,059 to 1,000 among the white, and 1,020 to 1,000 among the negro population.

But this excess of males over females is soon removed. The superiority of the female in the struggle for survival is shown markedly in the first day after live-birth, through every week of the first month, and in each trimester of the first year of extra-uterine life; and it is shown in American and in English experience alike. By the end of the second year of extra-uterine life, girls outnumber boys. That greater facility of birth of females owing to a smaller cranium is not the sole cause is evidenced by the persistence of the phenomenon of superior vitality.

TABLE IV

DEATH RATE AT EACH PERIOD OF INFANCY PER 1,000 BIRTHS

	England and Wales, 1918		United States, birth registration area, 1918	
	Males	Females	Males	Females
Under one day	12.6	9.6	17.6	13.1
1 day and under 1 week	13.3	10.7	17.0	13.1
2nd week	6.0	4.9	6.5	5.4
3rd "	5.2	3.8	4.8	3.9
4th "	3.9	2.8	3.7	3.1
Total under 1 month	41.0	31.8	49.6	38.6
1 to 3 months	18.9	15.0	17.1	13.7
3 to 6 "	18.1	13.6	17.9	14.5
6 to 9 "	15.6	12.6	14.5	12.7
9 to 12 "	14.3	13.0	11.7	11.1
	107.9	86.0	110.8	90.6

DEATH RATES AT DIFFERENT AGES: INCREASES AND DECREASES

For the registration area of the United States, comparisons are possible only between 1900 and subsequent years. In Table V the American experiences for the single years 1900 and 1911 are quoted from the Mortality Statistics, 1911 (Bureau of Census), page 22. The death rates for the same years and ages are given for England and Wales.

TABLE V

MALES: DEATH RATE PER 1,000 LIVING AT EACH AGE

Year	0–	5–	10–	15–	20–	25–	35–	45–	55–	65–	75 and over
1900 England and Wales	61.6	4.2	2.3	3.7	5.1	6.7	11.7	19.9	37.1	74.2	168.3
United States reg. area	54.2	4.7	2.9	4.9	7.0	8.3	10.8	15.8	28.9	59.6	146.1
1911 England and Wales	46.2	3.5	2.0	3.0	3.9	5.0	8.0	14.8	29.7	63.5	150.4
United States reg. area	39.8	3.4	2.4	3.7	5.3	6.7	10.4	16.1	30.9	61.6	147.4

The differences are interesting, but it is desirable to compare the experience of other years before final conclusions are drawn. In 1900, at ages 0–5 and at all ages over 35, registration America had a more favorable male death rate than England; in 1911 its superiority at higher ages was confined to ages over 65. In 1900 the English death rate at ages 0–5 was 14 per cent and in 1911 was 16 per cent higher than that of America (registration area). Evidently, then, in view of the higher infant mortality in America, the death rate at ages over 1 and under 5 is lower in the United States than in England, a subject worthy of further study. For all ages the standardized death rate of England and Wales was 19.9 per 1,000 population in 1900, and 15.6 in 1911; in the original registration area of the United States it was 17.6 in 1900, and 15.3 in 1911; there being a 22 per cent improvement in England, and a 13 per cent improvement in the registration area.

THE INCIDENCE OF REDUCED DEATH RATE AT DIFFERENT AGES

In the next table is shown the historical trend of the death rates of England and Wales in five successive decennial periods, the increase or decrease of the death rate for various age groups being displayed.

TABLE VI

INCREASE OR DECREASE PER CENT OF THE DEATH RATE FOR EACH SEX AND AGE-GROUP COMPARED WITH THE DEATH RATE FOR THE SAME GROUP IN THE IMMEDIATELY PRECEDING DECENNIUM

	England and Wales				United States
	1871–80 compared with 1861–70	1881–90 compared with 1871–80	1891–1900 compared with 1881–90	1901–10 compared with 1891–1900	1911 compared with 1900
Males					
under 5	−6.9	−10.0	+1.8	−20.2	−26.6
5–	−18.1	−20.3	−19.4	−18.7	−27.7
10–	−17.3	−20.4	−17.1	−16.1	−17.2
15–	−15.1	−17.8	−12.2	−18.5	−24.5
20–	−13.1	−22.1	−11.7	−17.4	−24.3
25–	−6.0	−16.9	−13.0	−17.6	−19.3
35–	+2.3	−10.2	−7.2	−20.4	−3.7
45–	+4.2	−3.5	−2.2	−14.4	+1.9
55–	+5.2	−0.5	+0.7	−9.0	+6.9
65–	+3.9	+1.1	−0.1	−7.9	+3.4
75 and over	+2.3	−3.9	−1.6	−4.8	+0.9
Females					
under 5	−8.4	−11.0	+1.6	−20.7	−27.3
5–	−20.1	−15.6	−16.9	−17.3	−32.6
10–	−17.5	−16.4	−17.5	−15.6	−32.3
15–	−17.9	−18.9	−17.1	−21.1	−31.3
20–	−14.6	−18.7	−19.5	−21.6	−29.9
25–	−11.4	−14.4	−17.5	−22.0	−26.8
35–	−3.6	−9.0	−9.4	−21.5	−15.3
45–	−0.2	−3.3	−2.4	−15.1	−9.2
55–	+2.7	−0.7	−0.1	−12.6	+0.8
65–	+3.2	−1.0	+0.5	−11.2	+2.4
75 and over	+0.8	−5.2	−1.1	−7.0	−0.2

The table shows also a similar comparison between the experience of 1911 and 1900 for the registration area of the United States.

It will be noted that the American experience displays for the later period an increased death rate in men at all ages over 45, and in women at ages 55 to 75.

When the experience of 1871–80 is contrasted with that of 1861–70, the English experience shows an increased death rate at all ages over 35 for males, and at ages over 55 for females. When 1881–90 is contrasted with 1871–80 there is no evidence of increased death rate at any age except in men aged 65–75; and the experience of the 20 years 1891 to 1910 shows a declining death rate in both sexes at all ages, with the exception of a slight increase at ages 55–65 in males and at ages 65–75 in females in 1891–1900, owing probably to the influenza pandemic of 1889–93. The evidence is definite that there has been steady advance in the age to which increasingly favorable death rates extend.

Thus, a comparison of the experience of (the death registration area of) the United States with that of England and Wales shows that the registration area stands historically in respect of increase or decrease of death rate at various stages of life approximately where England stood in 1871–80; and it is not very hazardous to make the same forecast for the United States that I ventured to make for England in the year 1893 when the first *Brighton Life Table* was prepared by me.* In that publication, I pointed out that:

> "It is evident that although in England, owing to the large number of lives saved during the early years of life, the number surviving to the higher ages has increased, thus securing a great gain to the community, this is not incompatible with a stationary or even diminished prospect of life for each individual over a certain age. In England the death rate for males was higher in 1871–80 for *all age-groups above the 25-35 period,* and for females was higher in 1871–80 for all age-groups above the *35–45 period* than in preceding decennial periods."

After discussing the influence of increased wages and improved nutrition in more than counterbalancing the unfavorable influence of city conditions of life, I laid stress on the following factor which must, I believe, be given a large share of the credit for the reduced death rate at older as well as at younger ages which has now been realized.

> "Another consideration requires to be borne in mind. We are at present in a transition period. The Public Health Acts of 1871 and 1875 heralded immense improvements in sanitation, the fruits of which have not yet been fully reaped. There has been, more especially since 1875, steady and increasing improvements in the conditions under

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* See also p. 316 of the author's *Elements of Vital Statistics*, 1899.

which people live. Men now 40 years of age were born in the pre-sanitary period; and the first 20 years of their life were spent under more unhygienic conditions than those now holding good. This fact would go far towards explaining a stationary death rate at the higher ages. It does not, however, explain an increased death rate at those ages.

The explanation of this increased death rate at the higher ages will probably be evident when at the end of another 20 or 30 years the improved conditions of life have endured sufficiently long to enable their full force and value to be determined. We must be content in the meantime to have stated the more important factors which appear to be at work, leaving the complete solution of the problem to a time when the statistical experience of our country is more mature."

At the end of the time asked for in the foregoing comment, it is noteworthy that at every age, even beyond 75 years of age, the number dying for a given number at risk has decreased; and the improved conditions of modern life, sanitary, social, and economic, have resulted in England in a lowered death rate at every recorded age-period.

It is unfortunate that a similar comparison can be made for the registration area of the United States only for 1900 and 1911; which, as already stated, displays a difference similar to the one displayed when the English death rates at different ages in 1871–80 are compared with corresponding death rates for 1861–70.*

CHANGES IN ADULT MORTALITY

Having given a brief outline of the general lowering of the death rate at every period of life and having shown the greater share of women in this improvement, I propose now to confine my observations to the historical changes after the age 25, and more particularly to events after the 40th milestone of life has been passed, as it is especially concerning this period of life that our professional pessimists—as always in the past—insist that we are "going to the dogs."

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* This statement gives the historical position. It will be noted, however, that the standardized total American death rate in 1911 was 15.3 as compared with 15.6 for England and Wales. I am able to give the following additional contribution to the historical position. In the annual report of the Massachusetts Board of Health for 1896 is given a comparison of the death rate according to age for both sexes in combination in 1875 and 1895 respectively.

DEATH RATE, MASSACHUSETTS, U. S. A.

	0–	5–	10–	15–	20–	30–	40–	50–	60–	70–	80–
1875............	73.9	9.8	4.7	7.7	10.5	11.3	13.0	18.3	34.8	71.1	176.4
1895............	64.5	6.2	3.2	5.3	7.1	9.7	12.7	20.5	39.4	82.4	184.7

It will be noted that the death rate had increased between 1875 and 1895 at each age-period after 50. A somewhat similar increase has occurred between 1900 and 1911.

It is particularly unfortunate that these historical comparisons, owing to the absence of comparable American data, must for the present be limited chiefly to English experience with a relatively stable population and long experience of accurate vital statistics. For England and Wales as a whole, a consecutive series of life tables makes possible comparisons for a long series of years. In the following tables the facts are shown for males.

TABLE VII

LIFE TABLES FOR MALES

A—NUMBER OF SURVIVORS AT HIGHER AGES, OUT OF 1,000 BORN

Experience of	England and Wales				Massachusetts, U. S. A.	
	1838–54	1881–90	1901–10	1910–12	1893–97	1909–11
No. at birth	1,000	1,000	1,000	1,000	1,000	1,000
No. at age						
25	624	694	745	779	680	760
30	595	669	727	762	651	739
35	564	640	705	742	620	713
40	532	605	677	717	588	683
45	496	564	642	685	554	646
50	456	518	599	643	515	604
55	409	463	544	590	468	551
60	356	398	476	521	411	482
65	295	322	393	435	344	395
70	223	239	299	334	267	296
75	148	154	198	224	185	197

B—NUMBER OF SURVIVORS AT HIGHER AGES OUT OF 1,000 AT AGE 25

	England and Wales				Massachusetts, U. S. A.	
No. at age						
25	1,000	1,000	1,000	1,000	1,000	1,000
30	954	964	976	978	958	972
35	904	922	946	952	912	938
40	852	872	909	920	865	899
45	794	813	862	879	815	850
50	731	746	804	826	758	795
55	655	667	730	758	688	725
60	570	574	639	669	604	634
65	473	464	528	558	506	520
70	357	344	401	429	393	389
75	237	222	266	288	272	259

C—NUMBER OF SURVIVORS AT HIGHER AGES OUT OF 1,000 AT AGE 40

	England and Wales				Massachusetts, U. S. A.	
No. at age						
40	1,000	1,000	1,000	1,000	1,000	1,000
45	932	932	948	956	942	946
50	857	856	885	897	876	884
55	769	765	804	823	796	807
60	669	658	703	727	699	706
65	556	532	580	606	585	578
70	420	395	442	466	454	433
75	278	255	291	312	315	288

Table VII A shows that in each successive life table the number of survivors to the age 25, out of equal numbers born, has continuously increased with lapse of time. The subsequent course of events for adult life can more accurately be followed in Table VII B. It will be seen that with the exception of ages 60 and upwards, in the decennium 1881–90, the number of survivors out of every 1,000 reaching the age of 25 years has steadily increased until after the Psalmist's term of life is passed. Similarly, out of every 1,000 reaching 40 years of age (Table VII C), with the exception of ages 55 and upwards, in 1881–90, improvement in expectation of life is shown at all ages over 40. These tables give no evidence of national deterioration at higher ages. They show, on the contrary, increased longevity in each succeeding period. This is further illustrated in Figure I.

For the United States death registration area* historical comparisons are practicable only for 1900 onward, except for Massachusetts, for which Dr. S. W. Abbott, the secretary of the then State Board of Health, constructed a life table based on the experience of the years 1893–97,† the data for which are probably comparable with those for Massachusetts published in the life-table volume of the Federal Census Bureau. In this volume is given *inter alia* a life table for Massachusetts, based on the experience of 1909–11; and in Table VII these two experiences are compared.

When the whole of life is taken into account the results in Massachusetts show improved prospects of life in every age-period; so in the main do the figures for equal numbers starting at age 25; but for equal numbers starting at age 40, there appears to be slight vital deterioration from age 65 and upwards.

Although the material for historical comparisons in the United States is scanty, the series of life tables issued by the Bureau of the Census, based on the deaths in the three years 1909–11 and the population of 1910, gives valuable material for almost contemporaneous comparison with the data for England and Wales. Dr. William H. Davis, the chief statistician for vital statistics of the Census Bureau, informs me that the English and the American life tables are comparable with respect to methods of construction. In Table VIII are compared the number of survivors out of 1,000 males at birth, at age 25, and in each successive five additional years of age. The columns are arranged in order of the number of survivors to the highest age, beginning with the experience of greatest vitality.

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* This area comprised in 1900, 40.5 per cent of the total population of the United States.

† The 30th Annual Report of the State Board of Health of Massachusetts for 1898 gives also an earlier life table *for persons* in Massachusetts dealing with the experience of the year 1855.

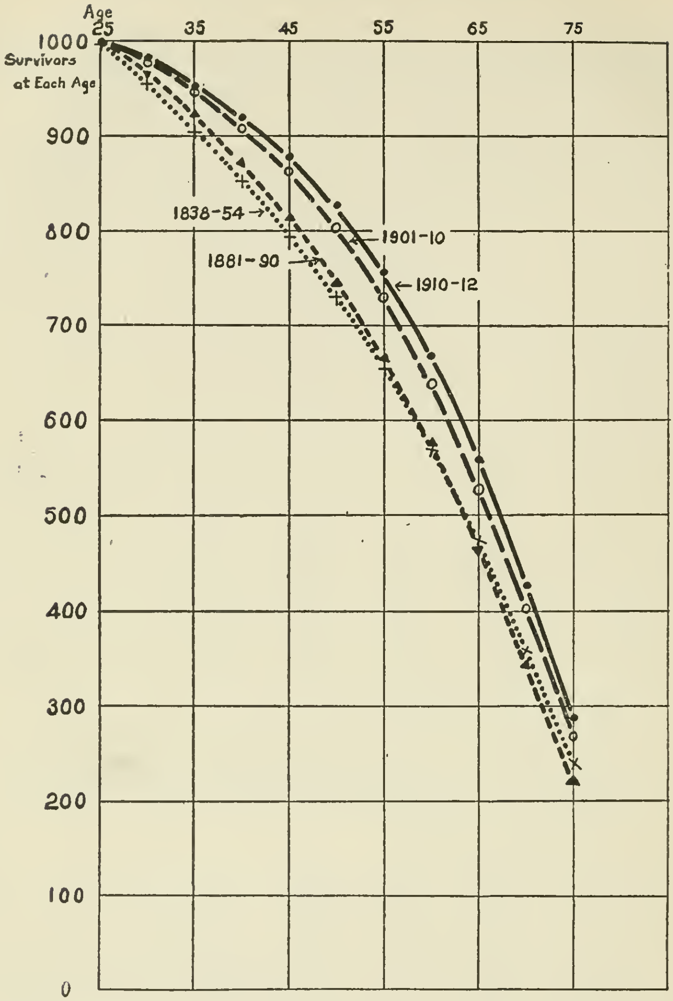

FIGURE I. LIFE TABLE EXPERIENCE, ENGLAND AND WALES, FOR FOUR PERIODS. Number of male survivors at each subsequent age out of 1,000 at age 25, in 1838-54, 1881-90, 1901-10, and 1910-12.

It will be noted that the aggregate white males in the rural parts and in the whole of the registration area, and the population of the states of Indiana and Michigan showed the largest number of survivors to age 25, Michigan coming next.*

In Figure II the relative experience of urban and rural populations and of Massachusetts is shown.

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* Separate life tables have been published for Indiana, Massachusetts, Michigan, New Jersey, and New York.

TABLE VIII

UNITED STATES LIFE TABLES, 1909–11, FOR MALES

A—NUMBER OF SURVIVORS AT HIGHER AGES OUT OF 1,000 BORN

	Total white males (rural parts)*	Native-born white males*	Total white males*	White males in cities*	Indiana	Michigan	New Jersey	New York	Massachusetts
No. at birth.	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
No. at age									
25......	806	768	770	751	804	791	764	756	760
30......	785	744	748	728	782	771	741	731	739
35......	763	716	721	698	757	749	712	701	713
40......	738	683	688	662	732	725	677	662	683
45......	710	648	651	619	702	698	637	619	646
50......	677	608	607	569	667	663	591	569	604
55......	637	561	556	510	628	621	537	511	551
60......	581	501	490	435	570	565	466	440	482
65......	506	426	409	347	498	489	381	358	395
70......	409	337	315	253	404	393	288	269	296
75......	294	237	216	162	290	279	194	180	197

B—NUMBER OF SURVIVORS AT HIGHER AGES OUT OF 1,000 AT AGE 25

No. at age									
25......	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
30......	974	969	971	969	973	975	970	967	972
35......	946	932	936	929	942	947	932	927	938
40......	916	889	894	882	911	917	886	876	899
45......	881	844	846	824	873	882	834	819	850
50......	840	792	788	758	830	838	774	753	795
55......	790	731	722	679	781	785	703	676	725
60......	721	652	636	579	709	714	610	582	634
65......	628	555	531	462	619	618	499	474	520
70......	507	439	409	337	503	497	377	356	389
75......	365	308	280	216	361	353	254	238	259

C—NUMBER OF SURVIVORS AT HIGHER AGES OUT OF 1,000 AT AGE 40

No. at age									
40......	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
45......	962	949	946	935	959	963	941	934	946
50......	917	890	882	860	911	915	873	859	884
55......	863	821	808	770	858	857	793	772	807
60......	787	734	712	657	779	779	688	664	706
65......	686	624	595	524	680	675	563	540	578
70......	554	493	458	382	552	542	426	406	433
75......	398	347	314	245	396	385	287	272	288

* In the original registration states.

The picture is not materially changed when the survivorship of 1,000 men starting at age 40 in each of these states is contrasted. The populations living preponderantly in cities evidently occupy an inferior position. That the conditions of city life explain, largely at least, the marked differences of vitality in the different states is suggested by the partial coincidence between degree of urbanization and paucity of survivors. At the census of 1910, 92.9 per cent of the population in Massachusetts was urban (*i. e.*, lived in districts with a population exceeding 2,500); 78.9 per cent in New York and 75.2 per cent in New

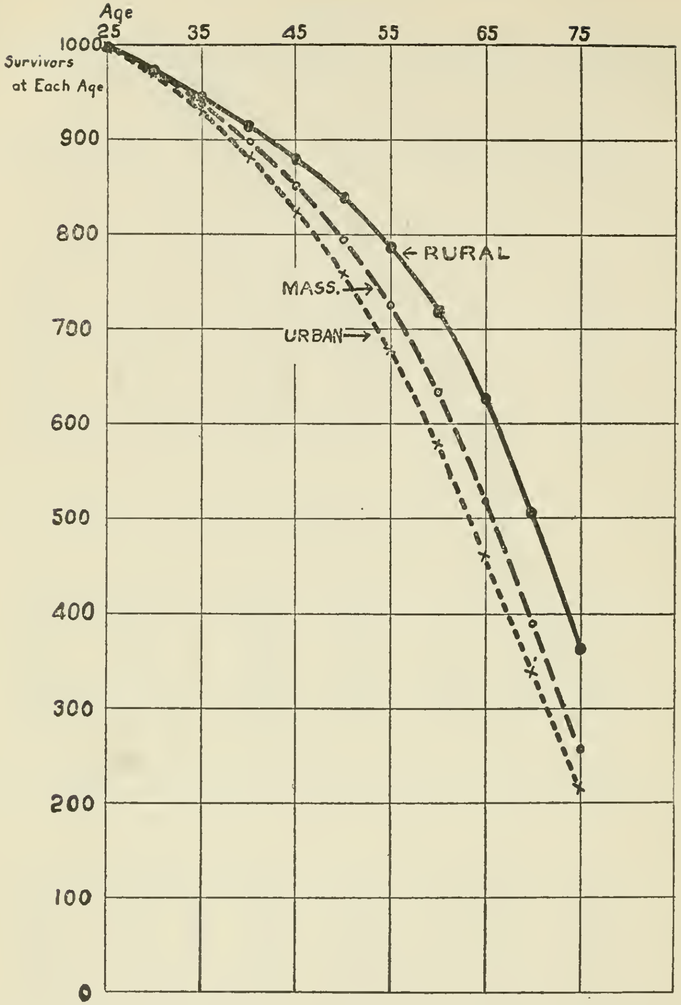

FIGURE II. LIFE TABLE EXPERIENCE OF THE UNITED STATES (1909–11). Number of male survivors at each subsequent age out of 1,000 at age 25 in the aggregate urban and rural white populations of the original registration states and in Massachusetts.

Jersey, as against 47.2 per cent in Michigan and 42.5 per cent in Indiana. The proportion of foreign-born population in 1910 was about 32 per cent in Massachusetts and New York State; 29.5 per cent in New Jersey; 22.1 per cent in Michigan; and 9.2 per cent in Indiana. It may be added that for every 100 foreign-born persons in Massachusetts the highest proportion is Irish (21.2 per cent); in New York the greatest number are Russians (20.5 per cent), followed by Italians (17.5 per cent) and Germans (16.0 per cent).

If the experiences from age 25 onward be compared, rural males, the males of Michigan and of Indiana have approximately an equal number of survivors to the age 70, while Massachusetts, New Jersey, and the State of New York have relatively few.

Table IX compares the experience of males in England and Wales in 1910–12 with that of white males and of white native-born males in the registration area of the United States in 1909–11.

TABLE IX

A—NUMBER OF SURVIVORS AT HIGHER AGES OUT OF 1,000 BORN

	England and Wales	United States* 1909–11	
	Males 1910–12	All native-born white males	All white males
No. at birth	1,000	1,000	1,000
No. at age			
25	779	768	771
30	762	744	748
35	742	716	721
40	717	683	688
45	658	648	651
50	643	608	607
55	590	561	556
60	521	501	490
65	435	426	409
70	334	337	315
75	224	237	216
B—NUMBER OF SURVIVORS AT HIGHER AGES OUT OF 1,000 AT AGE 25			
No. at age			
25	1,000	1,000	1,000
30	978	969	971
35	952	932	936
40	920	889	894
45	879	844	846
50	826	792	788
55	758	731	722
60	669	652	636
65	558	555	531
70	429	439	409
75	288	308	280
C—NUMBER OF SURVIVORS AT HIGHER AGES OUT OF 1,000 AT AGE 40			
No. at age			
40	1,000	1,000	1,000
45	956	949	946
50	897	890	882
55	823	821	808
60	727	734	712
65	606	624	595
70	466	493	458
75	312	347	314

* Original registration states.

SUMMARY

The close similarity between the experience of the male population in adult life in England and in the United States is striking. It is, further, noteworthy that the inclusion of foreign with native whites does not result in a very marked change in survivorship at the higher ages.

Summing up the teaching of the preceding tables we arrive at the following conclusions:

1. The vital experiences of England and Wales and of the death registration area of the United States are very similar, and almost equal.
2. At nearly all ages, including the first year of life, females have an intenser inherent power of survival than males; and females have profited more than males from the increased vitality at all ages in recent years.
3. English experience shows in successive decennial periods a reduction of death rate which encroaches on the higher ages with advance of time. After the end of the decennium 1881–90, with an insignificant exception, each age up to the end of life has shared in the reduced rate of mortality.
4. Stated in terms of survivorship, out of every 1,000 reaching 40 years of age, improvement in expectation of life (depending on the summation of survivors at all higher ages) is shown at all ages over 40, with the exception of ages over 55 in 1881–90.
5. This temporarily increased death rate at higher ages, which was probably associated with the influenza epidemic of 1889–93, has been followed by a marked decline of death rate at these higher ages.
6. In English experience the satisfactory result is shown of a diminishing death rate at all ages, though on a much greater scale in the younger than in the more advanced years of life.
7. A comparison of the life-table experiences of Massachusetts at an interval of twelve to fifteen years gives no evidence of vital improvement.
8. The current life-table experience of the white population of the United States (registration area) is almost identical with that of England; the male population (whites) of both countries have an almost equal chance of survival to the age 25; and for equal numbers starting at age 25 or at age 40, the native-born white population of America has a larger proportion of survivors to the age 75 than the population of England.
9. The position of the negro is lamentable, assuming that in the registration area of the United States the figures are trustworthy.*

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* One thousand male negroes are reduced to one-half between their 34th and 35th birthday, while this does not happen for the white population before the 59th birthday is reached. I doubt whether

10. For the rural parts of the American population the expectation of life and the number of survivors to age 75 are much higher than in the entire registration area, while in cities and in the three states (New Jersey, New York, and Massachusetts) having a preponderantly city population, life is considerably curtailed.

INCREASE IN TOTAL DEATH RATE IN THE UNITED STATES AT AGES OVER 45

Three facts emerge prominently from the above study of American and English vital statistics: first, that in England there has for several decades been an almost continuous fall in the total death rate, affecting middle and advanced as well as early life; second, that the average positions of the white population of the United States (registration area) and of that of England are approximately equal; although, third, it appears that the male death rate at ages over 45 in the United States is still slightly increasing beyond what it was eleven years earlier. Why is this?

An explanation has already been suggested, if it be admitted that time is needed for the results of almost inseparable social and sanitary improvements to be felt at all ages. If, notwithstanding her vital position equal to that of England (owing, possibly, to the higher wages, better nutrition, and less alcoholism of the mass of the American as compared with the mass of the English population), she is still historically in the position as to age distribution of death rate occupied by England in 1871–80, when the older portion of the English population had not enjoyed in their childhood the social-sanitary betterment which their children enjoyed, then we may anticipate an extension of the reduced death rate in the United States to all ages ere long.

This view of the reason for the failure of the American population at the higher ages to share in the reduced death rates of earlier life is confirmed by the complex position of this country with respect to immigration. As already seen, nearly one-third of the population of the states of Massachusetts, New York, and New Jersey are foreign-born, and of the remaining two-thirds about half have foreign parent-

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this figure can be trusted. Deficient birth registration among the negroes may have vitiated to some extent the life table estimates of negro population at ages 0–5, and increased the apparent death rate during this period. This would not, however, influence the number of survivors in a life-table population out of 1,000 males who reach age 25 as shown in the following table:

	Age										
	25	30	35	40	45	50	55	60	65	70	75
Total white pop. reg. area United States..	1,000	971	936	894	846	788	722	636	531	409	280
Negroes reg. area........................	1,000	938	865	787	704	614	516	413	309	213	130

age or mixed foreign and native parentage. These foreigners have come in varying proportions from Germany, Ireland, Italy, Russia, and Austria-Hungary, and in many cases they have in earlier life been constantly exposed to circumstances of malnutrition and insanitation; and, furthermore, in the earlier years of their residence in the United States they possibly have been subjected to excessive strain and privation in insanitary surroundings. It would be surprising if there were not a persistently high or even an increased death rate of persons at higher ages in the registration area. This subject has been elucidated statistically by Dr. Louis I. Dublin, who has shown that the foreign-born in New York and Pennsylvania experience a higher death rate than native-born of native parentage at nearly all older ages, and that this holds good also for native-born of foreign or mixed parentage.*

THE REGISTERED INCREASED MORTALITY FROM SPECIAL DISEASES

Having arrived thus far, we are now able to consider the statements frequently made as to special causes of alleged increased mortality at higher ages. The following statement, based doubtless on official published figures, may be quoted as typical of numerous similar statements published in scientific journals and in the daily press.

> "The death rate from degenerative diseases in the United States registration area has increased 41 per cent in 20 years. By this term is meant the wear-and-tear diseases such as cancer, arteriosclerosis, Bright's disease, etc., which are due to bad personal habits."

In examining the question as to whether this increase is real or apparent, or only partially real, we should remember the limitations of accuracy of medical certification of death. There has been steady improvement in medical certification, but this in itself has necessitated caution in accepting historical comparisons of diseases. The rule of safety in making historical comparisons is to confine such comparisons to individual diseases and not combine them into groups, as "circulatory," "renal," "nervous," and so on. The same rule applies, though to a lesser extent, when making contemporaneous comparisons. If I depart from this counsel of wisdom in what follows, it is to illustrate the dubiety attaching to the statistics thus displayed.

PNEUMONIA AND BRONCHITIS

Even for diseases like pneumonia and bronchitis there is some ambiguity in historical comparisons of statistics. There is not only change in medical fashions of certification, but also in one period a larger share of the pneumonia may be secondary to uncertified influenza, or of bronchitis or pneumonia to uncertified measles, than in another period. In the following curves the death rates from pneumonia and bronchitis in England and Wales among males at various ages over 25 for the two periods 1881–90 and 1901–10 are compared.

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* "The Mortality of Race Stocks in Pennsylvania and New York," by L. I. Dublin and G. W. Baker. *Quar. Publ. of the Amer. Statist. Assoc.*, March, 1920.

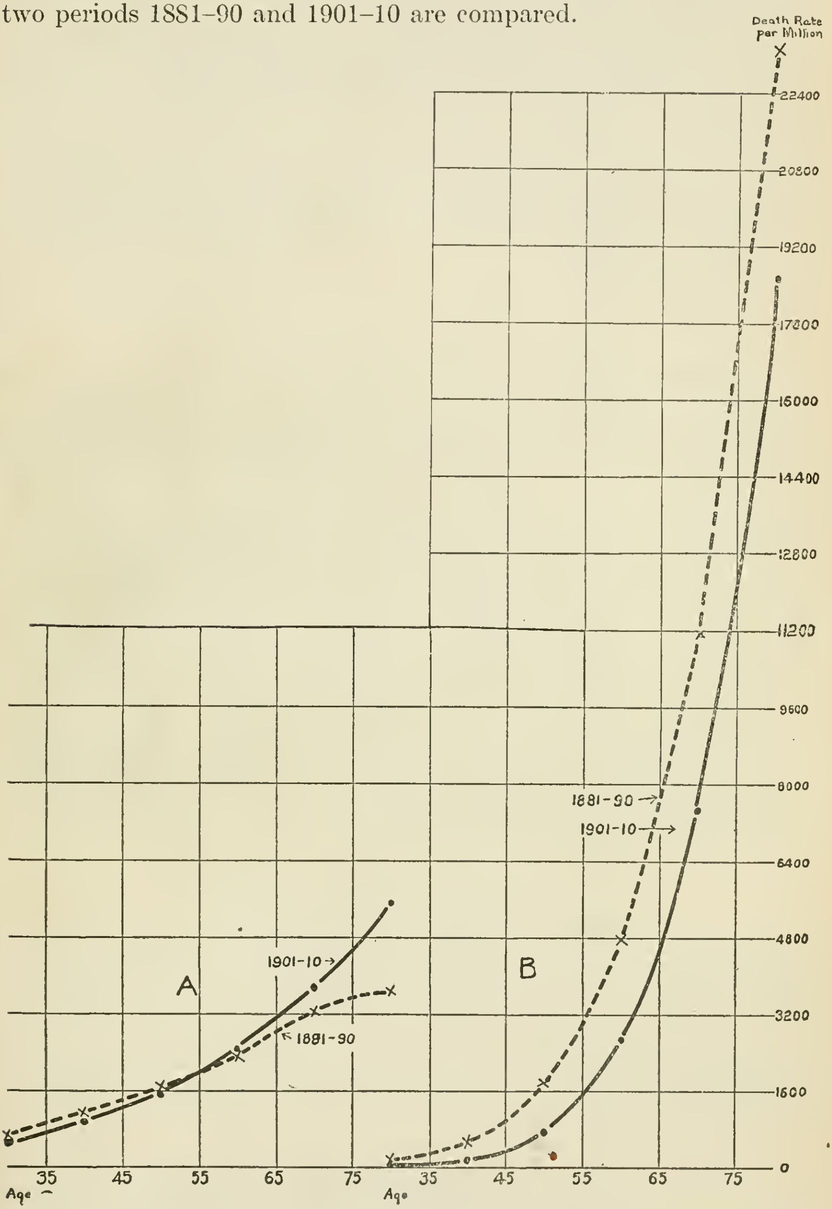

FIGURE III. DEATH RATE PER MILLION MALES AT EACH AGE PERIOD IN 1881–90 AND 1901–10 from

A. Pneumonia. B. Bronchitis.

The decline in the male death rate from bronchitis at each age-group is noteworthy, as is also the fact that in the decennium 1901–10 the death rate from pneumonia increased only at ages 65 and upwards. Notwithstanding the increased longevity of the population in the year 1918 in England and Wales, only 3.8 per cent of the total male deaths was attributed to old age or senile decay, while in the 25 years 1848–72 the number under this heading averaged 5.1 per cent of the total deaths. Even more striking as showing changes in medical certification is the following illustration of American experience, borrowed from a paper by Dr. L. I. Dublin on "The Registration of Vital Statistics and Good Business."

CARDIAC AND RENAL DISEASES

These considerations apply with even greater force when historical comparisons are made of the mortality from cardiac and renal diseases, as shown for the English experiences in 1881–90 and 1901–10 respectively (Figure V). After age 45 an increase is shown in the death rate (stated in terms of the population at the ages under risk) for each group of diseases, the maximum increase being at ages 65–75 and at 75 and upwards. To what extent this increase is real, and to what extent it arises from more accurate medical diagnosis and certification of the cause of death, cannot be stated with any degree of probability; but it must be borne in mind that this increase is associated with a reduction in the death rate from all causes in the aggregate at these very ages. The only absolutely certain facts are that on the average in English experience we live longer than in the past; but such as do not die literally of old age are certified in a larger proportion than in the past as having died of circulatory and renal diseases.

TUBERCULOSIS

The curves of English experience in 1881–90 and in 1901–10 for tuberculosis (Figure VI) show the decline in the death rate from this supremely important disease; also the gradual postponement of the age of maximum death-toll from it. We are more immediately concerned in this paper with mortality after middle life, and the curves bring out the too little remembered fact that tuberculosis remains one of the chief causes of death right up to old age.

CANCER

It would require a separate lecture to discuss the question of the increase of the registered death rate for cancer (shown in Figure VI).

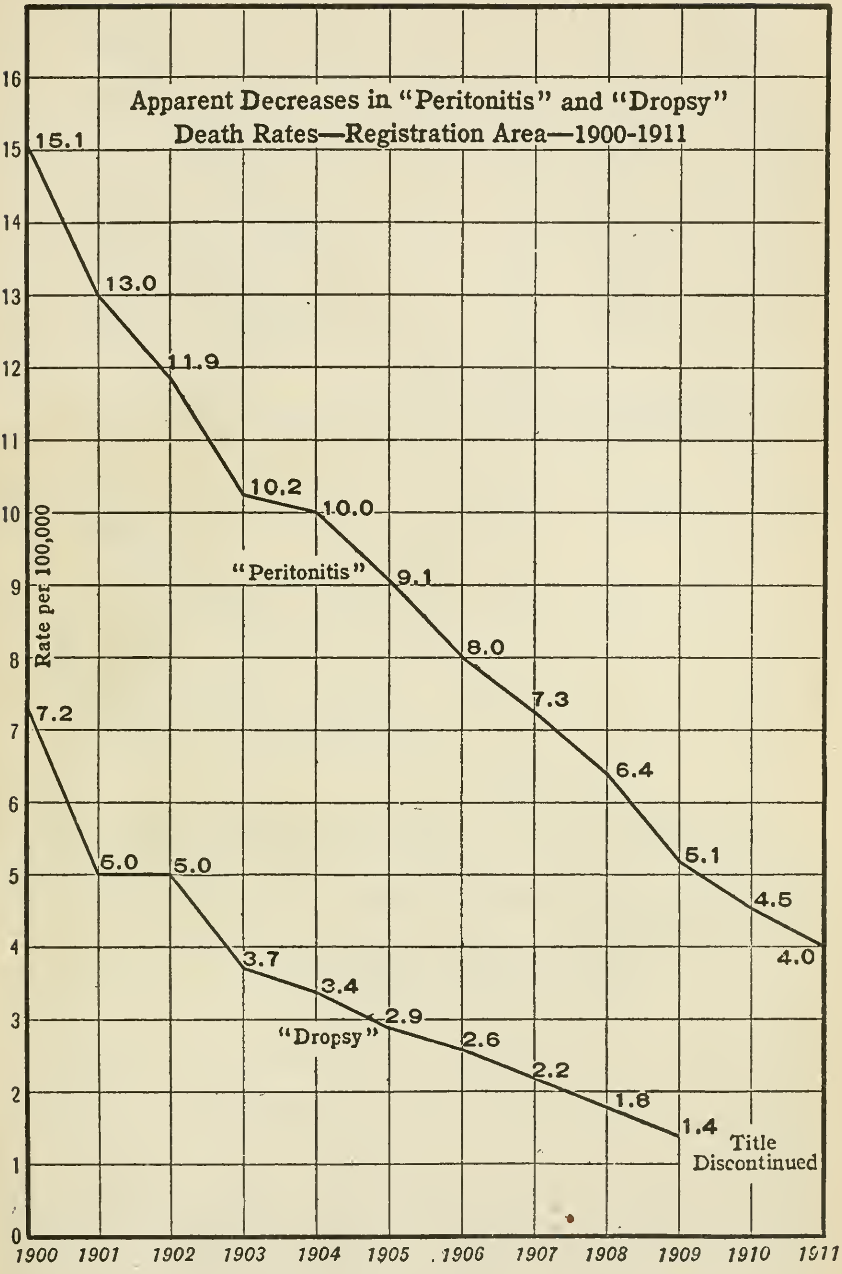

FIGURE IV. ILLUSTRATING TRANSFERENCE OF CAUSES OF DEATH

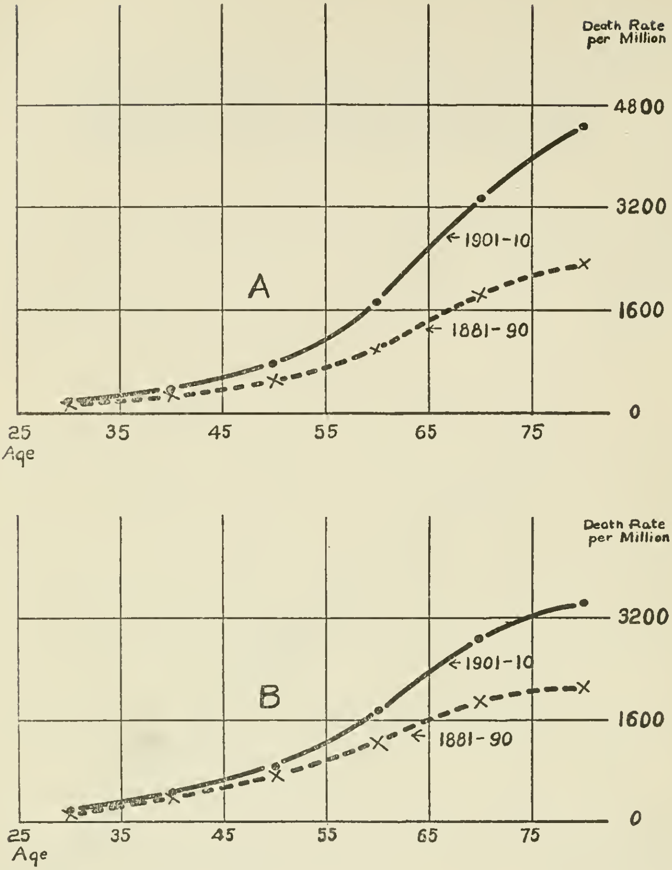

FIGURE V. DEATH RATE PER MILLION MALES AT EACH AGE PERIOD OVER 25 IN 1881–90 AND 1901–10.
A. Valvular disease of the heart, endocarditis and angina pectoris.
B. Acute and chronic nephritis, Bright's disease.

The balance of evidence appears now to support the view that cancer of certain organs has increased, although Professor W. F. Willcox, bringing up to date a paper by Mr. George King, F. I. A., and myself,* has recently come to the conclusion tentatively reached by us in 1893.

In this earlier paper the national returns for each division of the United Kingdom were subjected to accurate analysis, and statistics were given based on the death rate of Frankfort-on-Main for 1860–89, showing the incidence of cancer according to site. The conclusion

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* "On the Alleged Increase of Cancer," Proc. Roy. Soc., Vol. 54, 1893.

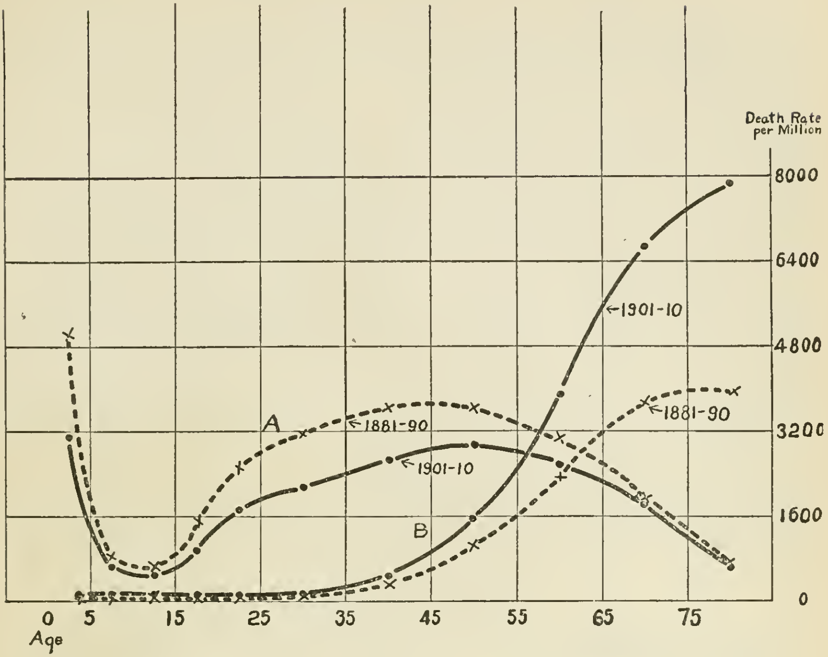

FIGURE VI. DEATH RATE PER MILLION MALES AT DIFFERENT AGE PERIODS IN 1881–90 AND 1901–10.
A. Tuberculosis (all forms).
B. Cancer.

reached was that the apparent increase of cancer is confined to "inaccessible" cancer of difficult diagnosis; and Professor Willcox has continued his comparison of cancer death rates in Frankfort down to 1913 with the result of confirming the earlier observations. The subject has been rediscussed in much detail by Dr. T. H. C. Stevenson in the annual report of the English Registrar General for 1917, in the light of English cancer data giving localization of the lesion; the conclusion he reaches is that in England "amongst males mortality from accessible cancer has increased more rapidly than from inaccessible, whereas amongst females the position is reversed, the result for both sexes jointly being a moderate excess of increase from inaccessible cancer."

In other words, the English figures do not support the conclusion drawn from the Frankfort figures, which at the time they were examined were the only figures available. Whether cancer mortality is increasing or not, the practical point is that from middle life onward it is one of the chief causes of premature mortality.

So far we have seen that a remarkable increase has occurred in the registered death rate at ages over 45 from certain diseases; and that this is associated with a declining death rate from all causes in the aggregate at these ages. The absence of a corresponding decline in the total death rate at these higher ages in the registration area of the United States is better explained by immigration of a diverse population than by the assumption that causes of degeneration are operating in the native-born population of the United States to an extent beyond that in England. Of course this does not imply that the conditions causing "degenerative diseases" do not require appropriate action in both countries. The English Registrar General in his *Decennial Supplement for 1901–10,* gives valuable tables of the death rate at various ages from 32 of the chief causes of death. From these tables the diagrams already given comparing the experience of 1881–90 and of 1901–10 for pneumonia, bronchitis, tuberculosis, cancer, and cardiac and renal diseases have been taken.

In the twenty years between the two periods the chief causes of death which showed decrease and increase respectively were as follows:

CAUSES OF DEATH

Group I. Decreasing
- Smallpox
- Measles
- Scarlet fever
- Whooping cough
- Croup
- Enteric fever
- Syphilis
- Tuberculosis
- Rheumatic fever and rheumatism of the heart
- Meningitis
- Epilepsy
- Laryngitis
- Bronchitis
- Pleurisy
- Violence

Group II. Increasing
- Influenza
- Diphtheria
- Diarrheal diseases
- Pneumonia
- Cancer
- Diabetes mellitus
- Valvular diseases of heart endocarditis
- Nephritis and Bright's disease
- Suicide

To supplement the evidence already stated, the following diagram may be studied. In A is shown the age distribution of the male death rate from all the diseases in Group I (above) in 1881–90 and in 1901–10 respectively. In B are displayed the corresponding facts for Group II; while in C is shown the age-distribution of the total male death rate from all other causes in the two decennia.

We thus see, as has already been displayed by the life-table method,

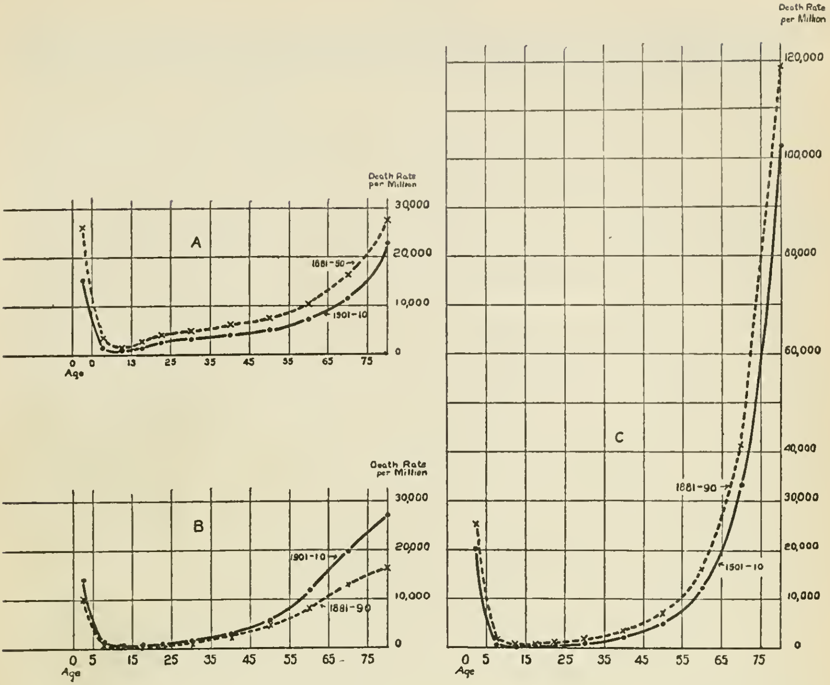

FIGURE VII. DEATH RATE PER MILLION MALES AT DIFFERENT AGE PERIODS IN 1881–90 AND 1901–10.

A. Group of diseases with decreasing death rate.*
B. Group of diseases with increasing death rate.*
C. All other causes of death.

that the balance is on the side of gain of life. For England we must decide between three possibilities: (1) increased mortality from certain diseases in middle and advanced life has been more than counterbalanced by decreased mortality from other diseases; (2) there has been merely transference of entries owing to gradually increasing accuracy of certification of deaths; or (3) these two factors are represented in the results to an uncertain extent.

For the registration area of the United States the situation is not so clear. As in England, there has been great increase in the registered mortality from certain diseases during middle and late life. Thus, Dr. Frederick L. Hoffman in a paper on "The Mortality from Degenerative Diseases," while deprecating hasty conclusions from imperfect data gives tables from which the following extracts are taken:

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*See list on page 710.

TABLE X

PERCENTAGE INCREASE OR DECREASE IN THE DEATH RATE FROM ALL CAUSES AND FROM EACH OF THE FOLLOWING DISEASES BETWEEN 1900 AND 1915

	At ages				
	30–40	40–50	50–60	60–70	70–80
Apoplexy and cerebral softening	+29.4	+11.1	+18.8	+33.3	+39.7
Heart and arterial diseases	+6.3	+19.8	+30.0	+56.3	+81.7
Kidney diseases	+21.0	+1.8	+22.2	+43.0	+64.1
All causes	−22.6	−8.5	+0.9	+5.8	+4.2

The total death rate for all causes at ages over 45 has also increased among males in the registration area, though to a relatively small extent. Furthermore, the prospects of survival to old age in the registration area are on the average equal to those of the English population; and it is likely that the increased death rate from all causes and from these "degenerative diseases" is due to the introduction of foreign populations, who have lived in youth, and possibly after arrival in this country, an arduous life of overstrain under circumstances of lower civilization with excess of infectious diseases.

He would be foolish who, in view of the foregoing broad facts for the average population, committed himself to a pessimistic view as to middle and late middle life in the future either for the English or the American white population. A more favorable view, however, is not incompatible with the existence of circumstances favoring or even producing premature decay in special groups. But these circumstances do not exist or are more than counterbalanced for the mass of our populations, which chiefly determines the trend of our national statistics; and it is all the more satisfactory—especially from a public health standpoint—that this should be so, in view of the increasing trend toward city life.

POSSIBILITIES OF DIMINISHING DISEASES AT AGES 40 TO 70

There is ample evidence to show that apparently irrespective of modes of life, longevity is the rule in certain families, while in others, equally apart from perceptible differences in mode of life, the arteries fail prematurely. It would appear that there is no condition in which the influence of heredity is more marked than in the capacity to attain old age.

Apart from this unequally distributed inherent capacity for old age, we must, if asked to state in a single formula the most serious impediment to the attainment of old age, agree that *injury due to infections is the chief cause of mortality.*

Next to infections as a cause of premature death comes malignant disease, the most pitiless of enemies, depriving us by cruel steps of those whose ripe judgment and mature knowledge make them almost irreplaceable. It is between the ages of 40 and 60 that men begin to repay the community for the varied expenses hitherto incurred on their account. Prior to this period the balance is often on the wrong side, and it is at these ages that cancer chiefly claims its victims.

In men in England at ages 45–55, one death out of 10.5 total deaths from all causes, at ages 55–65, one death out of 8.1, at ages 65–75, one death out of 9.6, and at ages over 75 one death out of 19.3 total deaths was due, in 1901–10, to this cause. And it still remains true that although in every civilized country earnest investigators are searching for a line of action which may be hopeful if not certainly successful, at present we can only point to the avoidance of protracted local irritations, and to the early diagnosis and treatment of the disease, as means of prevention of death in a certain proportion of cases.

We must confess our almost equally great inability with respect to catarrhal infections, whether ordinary catarrhs or their more serious congeners, bronchitis and pneumonia. Apart from avenues of hope with regard to pneumococcic infections, there is little prospect of early conquest over these diseases.

Pandemic influenza, with streptococcic secondary infection, has recently proved to be a more serious cause of death than a world war, and no action for its abatement, on a large scale, has been practicable.

Tuberculosis, although capable of being reduced to a shadow of its present importance, were we prepared to invest the necessary money and energy in continuous and complete action against it, still stalks the earth and cuts off a large share of our population, especially at ages when persons are just beginning to repay their communal indebtedness. Tuberculosis is also, much more than is recognized, a common cause of death at ages over 50, either as a chronic disease, often masquerading as senile bronchitis, or as an acute complication of other diseases. As tuberculosis becomes relatively less serious, cancer more than takes its place as a cause of premature mortality.

Diseases of the heart and blood vessels form a complex group and have diverse causation. Of the evil influence of excessive muscular work, of over-feeding, alcoholism, or excessive smoking, or other unhygenic personal habits in securing prematurely senile arteries and heart, I will assume that there is no doubt; but it is practically certain that such factors are of relatively small importance as compared with the havoc played by the multiple infections to which we are subjected. The chief enemies which prevent arteries and heart from fulfilling their duties to a robust old age are the specific infections of rheumatic fever, of syphilis, the pneumococci, and various streptococci from focal or other infections and still oftener secondary to an attack of an acute specific infectious disease.

We are now thoroughly advised of the magnitude of the mischief done by syphilis. Cerebral hemorrhage before the age of 40 or 45 may be assumed nearly always to owe its origin to this disease; and we know that more than one-tenth of the inmates of our lunatic asylums are there owing to syphilis, and die a premature death because of this infection. Will the community have the courage and wisdom to adopt the medical, police, social, and moral measures required to reduce it to insignificance?

It must be confessed that but little more appears to be known concerning rheumatic fever than when, in the Milroy Lectures for 1895,* I showed by elaborate mortality and sickness statistics derived from the general mortality experience of different European countries, from the general notification experience of Scandinavian countries, and from the experience of large general hospitals in England and other countries, that rheumatic fever is an epidemic disease of which widespread epidemics occur at intervals of a few years, though in the intervals it is never entirely absent from most communities. I drew attention to pandemics of rheumatic fever, particularly those of 1868, of 1874–75, and of 1884. I also showed that in England the epidemic prevalence of rheumatic fever has always occurred in years of exceptional scarcity of rainfall.

The causation of renal diseases or of arteriorsclerosis, apart from the influence of acute infectious diseases, is still obscure. We can, however, assert with a high degree of probability that if rheumatic fever could be avoided, if syphilis could be eliminated, and if the acute and chronic infectious diseases of childhood and youth and early manhood could be reduced to a shadow of their present dimensions, there would result an immense leap forward in the standard of health of the general community, and in the number of persons attaining a stalwart and healthy old age.

The chief and most promising line of attack on the disabling diseases of middle life and even of higher ages consists in the adoption of all known preventive and curative medical measures in childhood and in youth, adolescence and early manhood. It is chiefly in these years that the bill is incurred which has to be paid two, three, or four decades later. This does not imply, of course, that efforts made to anticipate and retard the onset of illness in older persons are fruitless. They are very desirable.

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* *Lancet*, May 9 and 16, 1895.

We have in fact a quadruple line of action open to us in securing a healthy life of physiologically normal duration:

1. To pursue the present lines of public health activities with complete efficiency, and thus reduce the prevalence of the infectious diseases (chronic and acute) which, though now controllable, are not controlled.
2. To undertake every additional line of public and private control of disease in the first twenty-five years of life which our more recent knowledge of preventive medicine shows to be practicable.
3. To adopt the same measures, as far as they are applicable, to ages over 25.
4. To follow every line of investigation which may enable us to secure further control over disease.

There can be no doubt that although every line of action indicated above must be followed to ensure success, the greatest and earliest results will be secured by a great increase of activities under the first two of these headings.

WITH INCREASE OF AVERAGE LENGTH OF LIFE HAS THERE BEEN IMPROVED HEALTH?

The facts already stated prove not only that out of a given number born, a larger number than formerly survive to the more useful years of life and to old age, but also that out of equal numbers taken at age 25 or even at age 40, the prospects of survival to old age have improved. Any doubt on this point, for the white population of the United States, results probably from the vast introduction of a foreign population belonging in large measure to a lower order of sanitary and social organization.

But these facts are not incompatible with the possibility that increased survival means a large amount of invalidism and inferior health in the population. Are we in the fullest sense living longer, or are we merely longer in dying? This problem cannot be discussed adequately in the present paper. I may be permitted to quote the following remarks written by me in 1893. At that time the death rate had increased in England at the higher ages, as it has recently done in the United States. But the general comments are relevant still.*

"1. A favorite explanation of the diminished expectation of life in adult years is that owing to the saving of life in the earlier years of life—a saving which has been especially in zymotic diseases and phthisis and other tubercular diseases—there has been a larger number of weakly survivors, who would under the former régime have been carried off by these diseases. In other words, the operation of the law of the survival of the fittest has been impeded, with results unfavorable to the health and vigor of adult life. This argument assumes that weakly children are more prone to attack by infectious diseases than robust children, an assumption which experience does not confirm. These diseases appear to attack the majority of children, weakly or robust, who are exposed to their infection. It might be reasonably expected, therefore, that with a decrease in the total deaths from infectious diseases, there would have been at least a corresponding decrease in the number of those who are left maimed by an attack of one of these diseases to survive to adult life. I personally think that the weeding out of weakly lives, caused by the greater mortality among weakly children suffering from an infectious disease, is almost entirely counterbalanced by the greater number of children made weakly in former times by non-fatal attacks of an infectious disease.

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* See Brighton Life Table, 1893, or *Elements of Vital Statistics*, p. 316.

The case for deterioration of the race by survival of patients who would formerly have died in early life from phthisis and other tubercular diseases, appears to be a stronger one. It is probable that a larger proportion of phthisical patients are cured than formerly. It is probable also that many more children with a strong tendency to phthisis or even suffering from its early symptoms are prevented by the improved medical treatment and the improved social conditions of recent years from developing the disease. These now may survive to adult life and become the parents of children with a strong tubercular tendency.

Such a fact need not, however, cause any serious apprehension for two reasons. In the first place, hereditary tendencies to phthisis act only under favorable predisposing conditions, such as damp and overcrowded houses, sedentary occupation in a cramped position, etc.; and in presence of the active exciting agent, the specific bacillus to which phthisis and other tubercular diseases are due. The exciting cause of tuberculosis is the introduction *ab extra* of the specific infection by inhalation or by means of food.

In the second place, assuming that more phthisical patients survive than formerly, is it not equally true that fewer persons *become* phthisical than formerly? With a diminution of the active cases of phthisis, the number of centers for phthisical sputum, the chief cause of subsequent infection, must have diminished to a corresponding extent. Of the fact that the predisposing causes of phthisis—damp and overcrowded houses, ill-ventilated workshops, etc.—are steadily diminishing, there is evidence on every hand. It is, therefore, reasonable to suppose that much at least of the deteriorating effect of survival of tubercular persons is counterbalanced by the large number of persons who are *prevented by improved sanitary and social conditions from becoming tubercular.*

It is premature at present to attempt by statistical means to determine how far the counteracting influences which are at work balance each other, or failing a balance, on which side is the preponderating effect.

2. The increased stress of modern life is supposed by many to explain the increased death rate among adults. It is doubtful if such increased strain exists in the community as a whole. Each adult as he becomes year by year more deeply involved in the battle of life, comes to the conclusion that the general strain of life in the community is increasing, forgetting that the same causes operated as life advanced in previous generations. There is reason for thinking with Dr. Pye-Smith that much of the evil ascribed to "over-pressure" is really due to over-feeding and drinking.

Assuming, however, that over-pressure exists in certain stations of life, *e. g.*, among city merchants, medical men, etc., it cannot be said to exist generally among professional men. Clergymen, lawyers, and civil-servants are as classes long-lived.

Even assuming that over-pressure exists throughout the whole of the professional and mercantile classes, these do not form the mass of the community. *The majority of the population of England and Wales belongs to the wage-earning classes*, and the conditions of these classes will therefore necessarily have the greatest influence on the total result.

Those conditions, as we know, have greatly improved.

I see no reason for altering the view stated in the preceding extract, except that I should now attach little if any importance to hereditary predisposition in tuberculosis, and should state my conclusions with less hesitation. Under the circumstances of modern civilization the assumption that natural selection can act as under savage conditions is completely unwarranted. Civilized life, leading to progressive improvement of environment and of personal habits, submerges any possible influence of natural selection in removing those unfit for survival, substituting for it a process of steady uplifting in fitness of the general population.

This is well illustrated in the following curves which show that infants who have escaped the assumed selective influence of a high infant mortality in infancy, continue to survive all through life in larger numbers than infants among whom excessive infant mortality has prevailed.

The recent recruiting figures have been adduced as evidence of widespread physical deterioration, and they doubtless show that both in this country and in the United Kingdom a large proportion of recruits suffered from physical defect or disease, rendering them unfit for military service. I have no wish to minimize the importance of these figures. That they indicate any deterioration in physique in the population, historically, is not proved, and is highly improbable.

In 1844 over half the recruits in Leeds were rejected; and in Birmingham and the surrounding towns in 1852 only one-third of the

	Mean Population, 1891–1900.	Mean Infant Mortality per 1,000 Births.
England and Wales	30,643,479	157
Selected Healthy Districts	4,477,485	109

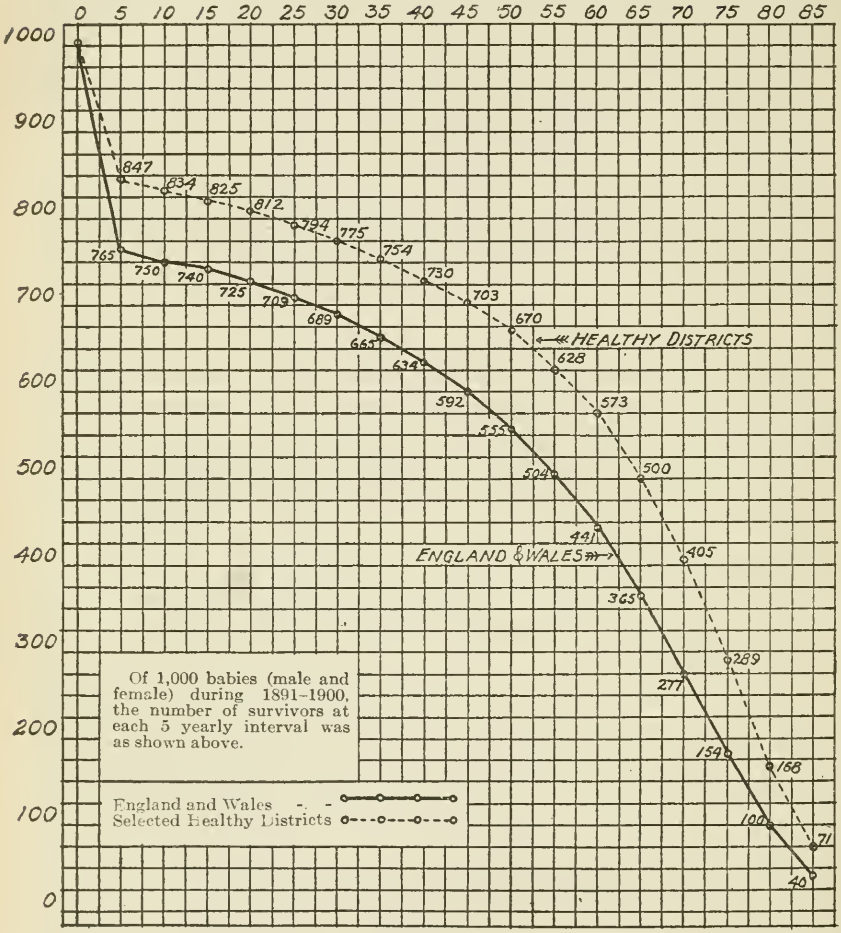

FIGURE VIII. Showing the number of survivors at each successive year of life out of 1,000 infants born in England and Wales and in selected healthy districts in 1881–90.

This table is to be read as shown in the following example:—At age 20 the number of survivors was 812 in healthy districts, 726 in the country as a whole; at age 60 was 573 in healthy districts, 441 in the country as a whole; and so on.

men who enlisted were approved. We have always thought we were a decadent race, and so have other nations before us. The ancient Greeks thought themselves to be degenerate, and the Spartans adopted the ill-considered action of exposing weakly infants to avoid this result. Sophocles is quoted by Dean Inge as stating that the best fate of man is "not to be born, or being born to die." Shakespeare refers to this "waning age" and has other similar passages. In 1721 Bishop Berkeley wrote an "essay towards preventing the ruin of Great Britain"; and you will remember Wordsworth's sonnet in which the following passage appears:

"Milton, thou should'st be living at this hour,
England hath need of thee: She is a fen
Of stagnant waters";

though he adds later:

"It is not to be thought of that the Flood of British freedom
* * *
That this most famous stream in bogs and sands
Should perish; and to evil and to good
Be lost for ever."

Every Tory Squire still believes that England is going to the dogs; but I prefer the sanguine view expressed by Tennyson as embodying the real outlook of both England and America:

"This fine old world of ours is but a child,
Yet in the go-car."

THE MATHEMATICAL REPRESENTATION OF FREQUENCY DISTRIBUTIONS

By Harry C. Carver, *University of Michigan*

Section I. DISTRIBUTIONS OF GRADUATED VARIATES
Section II. DISTRIBUTIONS OF INTEGRAL VARIATES
Section III. DIFFERENCE EQUATION GRADUATION*
Section IV. APPLICATION OF THE HYPERGEOMETRIC SERIES*

$$\text{(A)}\quad u_x = {}_{pn}C_{r-x}\ \ {}_{qu}C_x$$
$$\text{(B)}\quad u_x = {}_{pn}H_{r-x}\ \ {}_{qu}H_x$$

As an introduction to this paper on mathematical statistics the writer cannot refrain from quoting the first paragraph from the introduction of an extremely sound treatise on non-mathematical statistics, Zizek's *Statistical Averages*, a translation by Persons.†

> "In nearly all branches of statistical investigation averages or means are very often used for various purposes of the greatest significance. Averages are, therefore, undoubtedly to be reckoned among the most important aids in statistical method. Even Guerry, the founder of moral statistics, indicated the extraordinary importance of averages in the following definition of statistics: 'The science of statistics consists essentially in the methodological enumeration of variable elements, whose mean it determines.' Edgeworth defines statistics as 'the science of those means which are presented by social phenomena'; and similarly Bowley says, 'Statistics may rightly be called the science of averages.' The application of averages has, as is well known, given rise to controversies of various kinds, which fill a considerable part of statistical literature. Not infrequently the incorrect use of averages has also led to erroneous conclusions and to contradictions which have shaken our confidence in statistics. Averages, indeed, are only applicable under strictly defined conditions, and conclusions based on averages are likewise permissible only within well defined limits. It is the task of statistical science to investigate the application and use of averages from the general methodological standpoint, and to determine the part which averages should play in statistical method."

In astronomy and in other fields in which precise measurements are necessary, the average of a series of independent measurements of equal weight on an unknown quantity is assumed to give the best approximation to, *i. e.*, the most probable value of, the magnitude in question. But the computation of the mean, instead of permitting a final answer to the problem, only gives rise to other questions of a more involved character. Thus, we may require the "probable error" of the mean in order to estimate the extent to which we may rely on this average, or if this mean is to be combined with other means, it is necessary to know the approximate "weight" of each in order to insure a proper combination of observations.

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* Sections III and IV of this paper will appear in the September issue of the Quarterly Publications.

† New York: Henry Holt and Company, 1913.

In statistics it is likewise of the utmost importance that we be able to measure the dependability and the significance of averages. Thus, it may be quite necessary that we know that the average or normal weight of a male infant sixteen months old is 23.25 pounds, or that the average weight of a man who is thirty-seven years old and six feet tall is 179 pounds; but it is likewise important that we know to what extent these averages may be relied upon and be able to state to what extent a sixteen months old infant weighing 19 pounds or a thirty-seven year old male six feet in height and weighing 200 pounds, is abnormal.

Again, if from past experience we observe that certain abnormal conditions of rainfall and temperature seem to be associated with abnormal crops, we immediately feel that it would be desirable to know to just what extent these phenomena are on the average associated, and to be able to determine, if possible, a functional relation between cause and effect. Assuming that a mathematical representation of the law of cause and effect is obtainable, we must hesitate to place any confidence on any dependent prediction until we have investigated the dependability of the mathematical predictions.

It is quite clear that the dependability of a mean must be a function of both the number of observations used in computing the mean and the magnitudes of the variations about the mean. It follows,therefore, that a critical investigation of the distribution of magnitude-determinations about their mean is essential.

The fundamental problem of mathematical statistics is to develop an analytical expression that is capable of representing any distribution of magnitude-determinations, *i. e.*, *variates*. The Gaussian or Normal Curve of Error, Pearson's Generalized Probability Curves, and Charlier's Type A and Type B curves are all the results of investigations of this fundamental problem.

In this paper we shall first investigate the general problem of distribution from the point of view of a general mathematical representation rather than from the point of view of the theory of probability. The writer believes it possible to justify this deviation from the usual method of presentation.

SECTION I

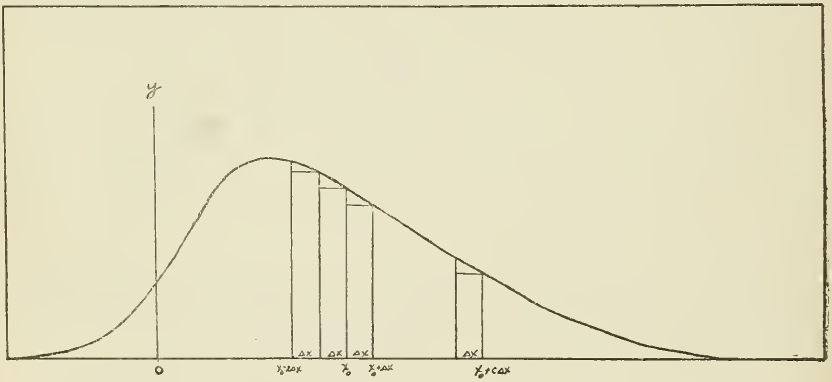
DISTRIBUTIONS OF GRADUATED VARIATES

Definition: *Graduated variates* are expressions of observed magnitudes which, from their nature, do not exist as integers but which may differ by infinitesimals.

We assume that variations from the mean follow some unknown law and that the observed class frequencies are approximations to corresponding areas under a theoretical *frequency function*, which affords a mathematical representation of the unknown law of distribution.

Let $f(x)$ be any frequency function which vanishes at $x=-l_1$ and $x=+l_2$, where the origin is taken at any point within the range. The limits may be either both finite, both infinite, or one finite and the other infinite.

Let the range $(-l_1, l_2)$ be divided into segments of equal length, Δx, and let ordinates be erected at each of the points of division. Now let rectangles be inscribed on these segments with altitudes equal to their respective right-hand boundaries.



Choosing one of these points of division as origin, the area of the rectangle whose right-hand boundary is at x_0 is

$$\Delta x \cdot f(x_0)$$

and that of any other rectangle whose right-hand boundary is $c \cdot \Delta x$ distant is

$$\Delta x \cdot f(x_0+c\cdot\Delta x).$$

Let us now set up the function

$$\sum_{c=-\frac{l_1+x_0}{\Delta x}}^{\frac{l_2-x_0}{\Delta x}} \Delta x \cdot f(x_0+c\cdot\Delta x)e^{(x_0+c\,\cdot\,\Delta x)\omega i}$$

where $i=\sqrt{-1}$ and ω is a parameter, and observe that if we multiply each term of this summation by

$$e^{-x_0\omega i}$$

and integrate the resulting series term by term with respect to ω we obtain the following identity

$$\int_{-\pi/\Delta x}^{\pi/\Delta x} e^{-x_0\omega i}\left\{\sum_{c=-\frac{l_1+x_0}{\Delta x}}^{\frac{l_2-x_0}{\Delta x}} \Delta x \cdot f\,(x_0+c\cdot\Delta x)e^{(x_0+c\,\cdot\,\Delta x)\omega i}\right\}d\omega=2\pi f\,(x_0).$$

This follows immediately from the fact that the general term of the summation after multiplication by

$$e^{-x_0\omega i}$$

and subsequent integration yields, for $c\neq 0$

$$\Delta x \cdot f\,(x_0+c\cdot\Delta x)\int_{-\pi/\Delta x}^{\pi/\Delta x}(\cos c\cdot\Delta x\cdot\omega+i\sin c\cdot\Delta x\cdot\omega)d\omega=0,$$

since c is necessarily an integer.

For $c\equiv 0$ we have

$$\Delta x \cdot f\,(x_0)\int_{-\pi/\Delta x}^{\pi/\Delta x} d\omega=2\pi f\,(x_0).$$

We have therefore

$$(1)\quad f\,(x_0)=\frac{1}{2\pi}\int_{-\pi/\Delta x}^{\pi/\Delta x} e^{-x_0\omega i}\left\{\sum_{c=-\frac{l_1+x_0}{\Delta x}}^{\frac{l_2-x_0}{\Delta x}} \Delta x \cdot f\,(x_0+c\cdot\Delta x)e^{(x_0+c\,\cdot\,\Delta x)\omega i}\right\}d\omega.$$

Now permitting Δx to approach zero we have

$$(2)\qquad f\,(x_0)=\frac{1}{2\pi}\int_{-\infty}^{\infty} e^{-x_0\omega i}\left\{\int_{-l_1}^{l_2} f\,(x)e^{x\omega i}dx\right\}d\omega.$$

Formula (2) is merely a form of Fourier's Integral.

If we now place

$$(3)\qquad \int_{-l_1}^{l_2} f(x)e^{x\omega i}dx = e^{c_0+c_1\omega i-c_2\frac{\omega^2}{2}}\left\{1+c_3\frac{\omega^3 i^3}{\underline{|3}}+c_4\frac{\omega^4 i^4}{\underline{|4}}+\ \ldots\right\},$$

the coefficients, c_n, may be evaluated by expanding

$$\int_{-l_1}^{l_2} f(x)e^{-c_0+\omega i(x-c_1)+c_2\frac{\omega^2}{2}}\,dx$$

in a power series of ω and imposing the condition that the coefficients of ω^0, ω^1 and ω^2 of the resulting series must equal 1, 0, and 0 respectively.

For values of c_n, $(n \geqq 3)$

$$c_n i^n = e^{-c_0}D_\omega^{(n)}\left.\int_{-l_1}^{l_2} f(x)e^{\omega i(x-c_1)+c_2\frac{\omega^2}{2}}\,dx\right]_{\omega=0},$$

and applying the operator formula

$$\phi(D)e^{ax}V = e^{ax}\phi(D+a)V$$

we may write

$$(4)\qquad c_n i^n = e^{-c_0}\int_{-l_1}^{l_2} f(x)e^{\omega i(x-c_1)}\left\{(D_\omega+i\,\overline{x-c_1})^n e^{c_2\frac{\omega^2}{2}}\right\}_{\omega=0} dx\Big]$$

$$= i^n e^{-c_0}\int_{-l_1}^{l_2}\left\{(x-c_1)^n-\frac{n^{(2)}}{2}c_2(x-c_1)^{n-2}+\frac{n^{(4)}}{2^2\underline{|2}}c_2^2(x-c_1)^{n-4} + \ \ldots\right\}f(x)dx,$$

where

$$n^{(r)} = n(n-1)(n-2)\ \ldots\ (n-r+1).$$

Imposing the condition that (4) must equal 1, 0, and 0 for $n=0$, 1, and 2 respectively, we have

$$e^{-c_0} = \frac{1}{\displaystyle\int_{-l_1}^{l_2} f(x)dx},$$

$$c_1 = \frac{\int_{-l_1}^{l_2} x f(x)dx}{\int_{-l_1}^{l_2} f(x)dx},$$

$$c_2 = \frac{\int_{-l_1}^{l_2} (x-c_1)^2 f(x)dx}{\int_{-l_1}^{l_2} f(x)dx}.$$

We see, then, that c_1 is the distance from the arbitrary origin to the mean and that c_2 is therefore the second moment of unit frequency about the mean, or in other words is the square of the standard deviation.

Representing, as is customary, by

b, the distance from the arbitrary origin to the mean,

σ, the standard deviation,

N, the total frequency of the distribution,

ν'_n, the n^{th} moment of unit frequency about the arbitrary origin,

$$\text{i.e. } \nu'_n = \frac{\int_{-l_1}^{l_2} x^n f(x)dx}{\int_{-l_1}^{l_2} f(x)dx},$$

ν_n, the n^{th} moment of unit frequency about the mean

$$\textit{i.e.} \quad \nu_n = \frac{\int_{-l_1}^{l_2} (x-c_1)^n f(x)dx}{\int_{-l_1}^{l_2} f(x)dx}$$

we obtain,

$$\nu_n = \nu'_n - {}_nC_1 b\nu'_{n-1} + {}_nC_2{}^2 b\nu^1{}_{n-2} - \cdots \tag{5}$$

$$c_n = \nu_n - \frac{n^{(2)}}{2}\sigma^2\nu_{n-2} + \frac{n^{(4)}}{2^2\underline{|2}}\sigma^4\nu_{n-4} - \frac{n^{(6)}}{2^3\underline{|3}}\sigma^6\nu_{n-6} + \cdots.$$

Referring to equations (2) and (3) we see that

$$f(x_0)=\frac{N}{2\pi}\int_{-\infty}^{\infty}e^{-(x_0-b)\omega i-\frac{\sigma^2\omega^2}{2}}\left\{1+c_3\frac{\omega^3 i^3}{\underline{\lvert 3}}+c_4\frac{\omega^4 i^4}{\underline{\lvert 4}}+\cdots\right\}d\omega.$$

If we now set

$$\phi_{x_0}=\frac{1}{2\pi}\int_{-\infty}^{\infty}e^{-(x_0-b)\omega i-\frac{\sigma^2\omega^2}{2}}d\omega$$

and note that

$$\phi_{(x_0)}^{(n)}=\frac{1}{2\pi}\int_{-\infty}^{\infty}e^{-(x_0-b)\omega i-\frac{\sigma^2\omega^2}{2}}(-\omega i)^n d\omega$$

we have finally, dropping the subscript on x, that any ordinate

(6) $$f(x)=N\left\{\phi_x-\frac{c_3}{\underline{\lvert 3}}\phi_x^{(3)}+\frac{c_4}{\underline{\lvert 4}}\phi_x^{(4)}-\frac{c_5}{\underline{\lvert 5}}\phi_x^{(5)}+\cdots\right\},$$

where from equation (5)

(7) $$\begin{cases} c_3=\nu_3 \\ c_4=\nu_4-3\sigma^4 \\ c_5=\nu_5-10\sigma^2\nu_3 \\ c_6=\nu_6-15\sigma^2\nu_4+30\sigma^6 \\ c_7=\nu_7-21\sigma^2\nu_5+105\sigma^4\nu_3 \\ c_8=\nu_8-28\sigma^2\nu_6+210\sigma^4\nu_4-315\sigma^8 \end{cases}$$

etc.

From the well-known definite integral

$$\int_{-\infty}^{\infty}e^{-a^2x^2}\cos bx\,dx=\frac{\sqrt{\pi}}{a}e^{-\frac{b^2}{4a^2}}$$

we see that

(8) $$\phi_x=\frac{1}{\sigma\sqrt{2\pi}}e^{-\frac{(x-b)^2}{2\sigma^2}}$$

Since the coefficients, c_n, are functions of the unknown law of distribution it would appear at first thought that we are now as far from having obtained a workable analytical expression for any distribution of graduate variates as we were at the start.

But although fluctuations in the values of individual class frequencies may arise as the result of "random sampling," we assume that the values of ν_n as computed from any observed frequency distribution will approximately equal the corresponding values which are functions of the *unknown* law of distribution. Certain theorems involving the theory of "probable error" enable us to ascertain the degree of approximation involved in this assumption.

It follows, then, that if equation (6) is so rapidly convergent that terms after the third or fourth may be neglected, it affords us a simple representation of any distribution.

The rapidity with which this series converges, however, depends upon the extent to which the generating function, ϕ_x, is a fair approximation of the unknown law of distribution. In general, if the distribution be approximately symmetrical, equation (6) is very rapidly convergent. If, however, the distribution be bimodal or extremely asymmetrical, series (6) as a function of the symmetrical generating function, ϕ_x, is for practical purposes of no value because

(a) the number of required terms in (6) would necessitate an impracticable amount of labor; and

(b) the probable errors of c_n for values of n greater than 5 or 6 are generally so large that the assumption that, for these, we may substitute the moments computed from the observed data for the theoretical moments, is open to serious criticism.

It should be understood, however, that theoretically equation (6) is capable of representing any frequency function associated with graduated variates, but that convergence means one thing and rapid convergence quite another.

In case the distribution is skew we may proceed as follows:

Let θ_x be any arbitrarily chosen function which may be used as a statistical generating function and which, being a frequency function, may be expressed by means of equation (6) in the series

$$(9) \qquad \theta_x = M\left\{\phi_x - \frac{d_3}{\underline{|3}}\phi_x^{(3)} + \frac{d_4}{\underline{|4}}\phi_x^{(4)} - \frac{d^5}{\underline{|5}}\phi^5{}_x + \quad \cdot \quad \cdot \quad \cdot \quad \right\},$$

where d_n is a function of the moments of θ_x.

Eliminating ϕ_x between (6) and (9) we obtain

$$(10) \qquad f(x) = \frac{N}{M}\left\{\theta_x - \frac{A_3}{\underline{|3}}\theta_x{}^{(3)} + \frac{A_4}{\underline{|4}}\theta_x{}^{(4)} - \frac{A_5}{\underline{|5}}\theta_x{}^{(5)} + \quad . \quad . \quad . \right\}$$

where

$$A_3 = c_3 - d_3$$
$$A_4 = c_4 - d_4$$
$$A_5 = c_5 - d_5$$
$$A_6 = (c_6 - d_6) - 20d_3(c_3 - d_3)$$

. . . . . .

The area under $f(x)$ between any two limits may now be computed since

$$(11)\qquad \int_a^b f(x)dx = \frac{N}{M}\left[\int \theta_x dx - \frac{A_3}{\underline{|3}}\theta_x^{(2)} + \frac{A_4}{\underline{|4}}\theta_x^{(3)} - \ \cdot\ \cdot\ \cdot\ \right]_a^b .$$

Inasmuch as tables for both the definite integral from 0 to x and $D^{(n)}(n=1, 2, 3, 4, 5, 6)$ have been computed for

$$\phi_x = \frac{1}{\sigma\sqrt{2\pi}}e^{-\frac{(x-b)^2}{2\sigma^2}}$$

it follows that in problems for which ϕ_x may be applicable, we are in a position to proceed with numerical computations.

It is highly desirable, however, that investigations be made in the endeavor to establish a reference list of generating functions possessing various desired properties. If the indefinite integral of any of these generating functions could readily be computed, such an investigation would be of the greatest value.

Again, since in the making of computations it would be much easier to obtain the numerical value of the n^{th} *difference* of θ_x than for the n^{th} *derivative*, it will be found of frequent advantage to utilize the following relation

$$D^n = \left(\Delta - \frac{\Delta^2}{2} + \frac{\Delta^3}{3} - \ \cdot\ \cdot\ \cdot\ \right)^n$$

and write (10) and (11) as

$$(12)\qquad f(x) = \frac{N}{M}\left\{\theta_x - \frac{B_3}{\underline{|3}}\Delta^3\theta_x + \frac{B_4}{\underline{|4}}\Delta^4\theta_x - \ \cdot\ \cdot\ \cdot\ \right\} \text{ and}$$

$$(13)\qquad \int_a^b f(x)dx = \frac{N}{M}\left[\int \theta_x dx - \frac{B_3'}{\underline{|3}}\Delta^2\theta_x + \frac{B_4'}{\underline{|4}}\Delta^3\theta_x - \ \cdot\ \cdot\ \cdot\ \right]_a^b \text{ respectively,}$$

where

$B_3 = A_3$ $\qquad$ $B'_3 = A_3$

$B_4 = A_4 + 6A_3$ $\qquad$ $B'_4 = A_4 + 4A_3$

$B_5 = A_5 + 10A_4 + 35A_3$ $\qquad$ $B'_5 = A_5 + \frac{15}{2}A_4 + \frac{55}{3}A_3$

$B_6 = A_6 + 15A_5 + 85A_4 + 225A_3$ $\qquad$ $B'_6 = A'_6 + 12A_5 + \frac{105}{2}A_4 + 100A_3$

. . . . $\qquad$ . . . .

In order that formulas 12 and 13 may be useful, it is necessary that the class interval be taken as the unit of x for θ_x and for all computed moments.

SECTION II

DISTRIBUTIONS OF INTEGRAL VARIATES

Definition: *Integral variates* are expressions of observed magnitudes which, from their nature, exist only as integers. For example: number of petals of a flower, number of persons in a family, etc.

We assume that variations from the mean follow some unknown law and that the observed class frequencies are approximations to corresponding *ordinates* of the theoretical frequency function which affords a mathematical representation of the unknown law of distribution.

We may readily write down an expression from which we may develop the general law of distribution for integral variates by placing c equal to unity in formula (1) of the preceding section. We have, then,

$$f(x_0)=\frac{1}{2\pi}\int_{-\pi}^{\pi} e^{-x_0\omega i}\left\{\sum_{x=-l_1}^{l_2} f(x)e^{x\omega i}\right\}d\omega. \tag{14}$$

Placing now

$$\sum_{x=-l_1}^{l_2} f(x)e^{x\omega i}=e^{c_0+c_1\omega i-c_2\frac{\omega^2}{2}}\left\{1+c_3\frac{\omega^3 i^3}{\lfloor\underline{3}}+c_4\frac{\omega^4 i^4}{\lfloor\underline{4}}+\quad\cdot\;\cdot\;\cdot\right\}$$

and proceeding exactly as before, we obtain, corresponding to (6),

$$f(x)=N\left\{\phi_x-\frac{c_3}{\lfloor\underline{3}}\phi_x{}^{(3)}+\frac{c_4}{\lfloor\underline{4}}\phi_x{}^{(4)}-\quad\cdot\;\cdot\;\cdot\right\} \tag{15}$$

where now the values of c_n are the same as those given in (7) if we now define

$$\nu_n=\frac{\Sigma(x-c_1)^n f(x)}{\Sigma f(x)}$$

and

$$\phi_x=\frac{1}{2\pi}\int_{-\pi}^{\pi} e^{-(x_0-b)\omega i-\frac{\sigma^2\omega^2}{2}}d\omega. \tag{16}$$

This ϕ_x may be eliminated as before, producing expansions corresponding to (10) and (12) .

DISCUSSION OF SECTIONS I AND II

In *Über das Fehlergesetz* and *Die zweite Form des Fehlergesetzes,* Charlier has shown that on the hypothesis of elementary errors any law of error may assume one of the two forms.

Type A

$$\phi_x + A_3\phi_x^{(3)} + A_4\phi_x^{(4)} + \cdots$$

Type B

$$\psi_{(x)} + B_1\Delta\psi_{(x)} + B_2\Delta^2\psi_{(x)} + \cdots$$

where

$$\phi_x = \frac{1}{2\pi}\int_{-\pi}^{\pi} e^{-(x_0-b)\omega i - \frac{\sigma 2\omega_2}{2}}\,d\omega,$$

and

$$\psi_{(x)} = \frac{e^{-\lambda}}{\pi}\int_{0}^{-\pi} e^{x\cos\omega}\cos(\lambda\sin\omega - \text{Ƶ}\omega)\,d\omega$$

$$= \frac{e^{-\lambda}\lambda^x}{\underline{|x}}$$

if x be an integer.

Owing to an oversight, π instead of ∞ appears as each limit of ϕ_x. The constants A_n and B_n are determined in *Über die Darstellung willkürlicher Funktionen* by applications of the method of moments, but appear to differ from the ones developed herein for values of n greater than (5) since by our general formula (5),

$$c_6 = \nu_6 - 15\sigma^2\nu_4 + 30\sigma^6,$$

whereas Charlier gives

$$c_6 = \nu_6 - 15\sigma^2\nu_4 + 15\sigma^6.$$

For values of n less than 6 the results agree.

As the result of the present investigation it would appear that there is no essential difference between Charlier's Type A and Type B curves, aside from the fact that both are merely special cases of formulas (10) and (12) when we define our generating functions as

$$\theta_x = \frac{1}{\sigma\sqrt{2\pi}}e^{-\frac{(x-b)^2}{2\sigma^2}}$$

and

$$\theta_x = \frac{e^{-\lambda}\lambda^x}{\underline{|x}} \text{ respectively.}$$

The fact that the second generating function may assume asymmetrical as well as nearly symmetrical forms renders the Type B curves more powerful than those of Type A.

It would appear, however, that for graduated variates the continuous limit of Poisson's Exponential Binomial Limit, namely, Pearson's Type III curve,

$$y=y_0e^{-\gamma x}\left(1+\frac{x}{a}\right)^{\gamma a}$$

placing $\nu_2=\nu_3$, might be more logically applied.

Again, if we do not impose on the above generating function the condition that $\nu_2=\nu_3$, it will be noted that any law of distribution may be written,

$$f(x)=N\left\{\theta_x+\frac{A_4}{\underline{|4}}\theta_x^{(4)}-\frac{A_5}{\underline{|5}}\theta_x^{(5)}+\quad\cdot\quad\cdot\quad\cdot\quad\right\},$$

where θ_x is the above mentioned Pearson's Type III function. Again we might use

$$f(x)=N\left\{\theta_x+\frac{B_4}{\underline{|4}}\Delta^4\theta_x-\frac{B_5}{\underline{|5}}\Delta^5\theta_x+\quad\cdot\quad\cdot\quad\cdot\quad\right\}.$$

Ordinarily

$$f(x)=N\left\{\theta_x+\frac{B_4}{\underline{|4}}\Delta^4\theta_x\right\}$$

will give practically the same results as any one of Pearson's Generalized Probability Curves, and will involve far less labor.

THE ORIGIN AND DEVELOPMENT OF MODERN TRADE STATISTICS

By Faith M. Williams, *Federal Reserve Board*

The compilation of foreign trade statistics is not a custom of recent origin. As M. Fernand Faure points out in his history of the "Development and Progress of Statistics in France,"* ordinances of the first quarter of the fourteenth century in France must have necessitated records of foreign trade. In 1305, Philip the Fair appointed a "Maitre des Ponts et Passages" whose duty it was to supervise, through the King's agents, all the goods entering and leaving French seaports; and an ordinance of 1324 imposed an export duty to be levied on the quantity, not on the value, of all goods leaving France.

Edward the Third seems to have been the originator of customs statistics in England. In 1374 we find that Geoffrey Chaucer (more famous as a poet than as a statistician) was appointed "Comptroller of the Customs, and Subsidy of Wools, Skins, and Tanned Hides in the Port of London, with the obligation to keep the records of his office with his own hand and to be continually present."† Few of these early records have been preserved, however. M. Chamberland, of the College of Chartres, published in 1892–3 in *La Revue de Geographie* a record of the commodities imported into France from Spain, Portugal, the Netherlands, Italy, the Levant, Germany, and England, which was drawn up somewhere between 1551 and 1556‡; but this document is almost unique. In general, little importance was attached to figures on foreign trade until the Mercantilist school appeared in the seventeenth century. The result of their convictions as to the necessity for a favorable balance of trade was a complicated network of commercial regulations and discriminating tariffs.§ The early Mercantilists evolved their theories and enacted laws enforcing them without any complete foreign trade statistics on which to base their reasoning, and by the end of the seventeenth century people began to see how dangerous their policies might become, particularly if they were not in accord with the real facts in the case.‖

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* *The History of Statistics*, published for the American Statistical Association, pp. 232–233.

† *Life of Chaucer*, Globe Edition, p. xvii.

‡ E. Levasseur, *Histoire des Classes ouvrieres avant 1789*. Vol. II, pp. 49–50.

§ As in England the prohibition of the export of gold and the Navigation Acts of Cromwell, and in France the high tariffs of Colbert.

‖ See Sir Dudley North's *Discourses on Trade*, 1691, and Pierre Boisguilbert's *Detail de la France sous le regne present*, 1697.

England seems to have been the first country to authorize the preparation of complete tables of imports and exports. As early as 1626 Charles I appointed a Commission of Trade, (1) to advance home Commodities, and (2) to repress the ungainfull Importacion of forraigne Commodities to the end Trade maie bee ballanced . . . .* Among the commissioners named in the decree as "fitt for this Imployment" is Thomas Mun, the author of *England's Treasure by Foreign Trade*† which gives one of the clearest accounts ever written of the balance of trade theory. The Commission of Trade established by Charles I disappeared about 1640, but it was revived under Cromwell.‡ During the latter part of the seventeenth century England was flooded with essays on trade, which were filled with estimates of increase in trade, balance of trade, and revenue from trade, culled from the incomplete records of the time. Sir Josiah Child published a *New Discourse on Trade* in 1668 and revised it in 1690; Sir William Petty combined essays on the trade of England, France, and Holland in a volume called *Essays in Political Arithmetic;* Sir William Temple wrote *Observations upon the United Provinces of the Netherlands* in 1672, and an *Essay on the Trade of Ireland* in 1673; and lesser writers like Dudley Digges, George Malynes, Edward Misselden, and Samuel Fortrey published books on similar subjects from 1615 to 1673, all without either complete nor reliable figures on which to base their arguments. Few of these men wrote as if they felt the need of more adequate information.

However, Sir William Petty and his friend John Graunt,§ who had determined to express themselves only in terms of "number, weight and measure," were not without their influence. In 1695 the House of Lords directed the Commissioners of the Customs to draw out an "accompt of all the Exportations from London and the Out-ports to every distinct country; also of all the Importations to London and the Out-ports from every distinct country, for the years 1694, 1695, 1696 and so on downwards. Every commodity is under a separate Head and the draw-backs upon Re-exportation are taken notice of, and the value is set down where the duty on goods is ad valorem."‖ Charles Davenant, an admirer of Petty's methods (although he deplored Petty's lack of statistical material), was instrumental in bringing this order about. In his little book *Of the Use of Political Arithmetic* (London, 1698), he says:*

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* W. Cunningham, *The Growth of English Industry and Commerce in Modern Times.* Part I, p. 175. Note.

† Published in 1664, twenty-three years after Mun's death.

‡ Cunningham, p. 175. Note. This commission has been continued in England until the present time as the Board of Trade.

§ Author of "Observations" upon the London Bills of Mortality.

‖ Davenant, p. 32.

> "There is hardly a Commerce, but the Dealers in it will affirm, we loose by all the rest; and yet 'tis evident that in time of Peace, the Kingdom gets by Trade in general.
>
> "A true Account of the Ballance of Trade will set all this aright, and show what traffics are Hurtful and what are beneficial to the Nation; but probably the Ballance is in no way to be found out, but by Political Arithmetic. . . . He that would, therefore, compute with any good effect in matters relating to trade must contemplate the Wealth, Stock, Product, Consumption, Shipping, Exportations and Importations of his Country; and at the same time he must consider the State and Conditions of other places.
>
> "In this Art, the most difficult Point is to find good materials and to have a Footing, probably sure, to fix our Reasonings upon . . . and in order to do this the House of Lords did in 1695 lay a most excellent foundation . . . and by this aid we hope to find out that Ballance of Trade which has been so often talked of."

It must not be supposed, however, that these complete records of trade, once begun, were published in detail. At stated intervals the total values of imports and exports were presented to Parliament, and on its request accounts of the trade in certain commodities—in corn, wine, or wool, or of the trade with certain countries—with France, the North American Colonies, or India were drawn off and inserted in the Parliamentary Papers.

It is now possible, therefore, to find an infinite variety of official foreign trade figures for the trade of the United Kingdom from 1694 on. However, no attempt was made to publish the complete details of that trade until the second quarter of the nineteenth century. Beginning in 1798 both the declared and the official values of the export trade had been recorded, and it soon began to be apparent that there were wide differences between the official and declared evaluations. A certain dissatisfaction with the methods used in compiling trade statistics grew up. In 1832 an attempt was made to present a complete picture of England's foreign trade from the material then available in the customs houses. In the Parliamentary Papers for that year there appeared† a detailed account of the quantity of the imports and the quantity and declared value of the exports of the United Kingdom by commodities and countries. The title of the document is as follows: "A Statement of the Imports and Exports of the United Kingdom for the year 1830, ended 5th January, 1831; distinguishing the Trade with each Foreign Country or British possession; and showing the principal Articles of Import and Export with the Quantities of such Articles, and in the case of British Merchandise, their declared value, together with a Statement of the Quantities of Imported Articles Retained for Home Consumption." (Mr. Courtenay.*)

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* Pp. 30–31.

† Parliamentary Papers, 1831–32. Vol. 34.

A more systematic presentation was desired, however, and in 1833, more than a century after complete records of foreign trade were begun, a special statistical division, under the charge of Mr. G. R. Porter,† was added to the Board of Trade. Within a short time Mr. Porter placed before Parliament an abstract of the annual trade of the United Kingdom from 1820 to 1831‡ which attempted to arrange the available facts with regard to this trade in an orderly and systematic fashion. The abstract contains the official values of the annual import, export, and re-export trade of the United Kingdom, the declared value of the export trade, and detailed figures with regard to the commerce in some 147 commodities. The details given as to the trade in each commodity vary greatly; in some cases there are only the quantities imported and exported each year; in the case of the grains the figures represent imports into *Great Britain,* including grain from Ireland; imports of cotton and wool and their manufactures are stated in great detail, distinguishing countries of origin and destination. In November, 1833, Mr. Porter published§ an account of the quantities of some 203 different commodities which entered into the foreign trade of the United Kingdom in 1831 and 1832, giving for some commodities countries of origin and destination. From that time on the communication to Parliament of detailed and systematically compiled statistics of imports and exports became an annual custom. In 1854, the method of publishing these statistics changed, and there appeared Volume I of the *Annual Statement of the Trade and Navigation of the United Kingdom,* in much the form in which it is now published.

France was not far behind the United Kingdom in beginning complete records of foreign trade. Arnould, in *La Balance du Commerce,*‖ says that in 1603 Sully used the registers of the five great custom houses to estimate the amount of revenue which would be received from an export tax of 15 sous per bale of merchandise exported. Colbert is supposed to have consulted these same records to get information as to importations, but neither Sully nor Colbert possessed complete records of French foreign commerce, nor did they think it worth while to ask for them.

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* Mr. Thomas Peregrine Courtenay was vice-president of the Board of Trade from 1828 to 1830 and a member of Parliament from 1810 to 1831.

† Mr. Porter was one of the Founders of the Royal Statistical Society, and the author of *The Progress of the Nation,* a statistical survey of the United Kingdom which was brought up to date and republished in 1912 by Mr. F. W. Hirst, editor of the London *Economist.*

‡ Parliamentary Papers, 1833, Vol. 41, Part I, p. 48, pp. 65 *et seq.*

§ Parliamentary Papers, 1833, Vol. 41, Part II, pp. 20 *et seq.*

‖ Vol. II, p. 118.

According to Monsieur Faure* it was Ponchartrain, Colbert's successor, who first asked in 1693 that detailed tables of importation and exportation be drawn up. However, the Bureau appointed to this task was not created until 1713. Arnould, who was at one time Chief of the Bureau de la Balance du Commerce, and who published in 1795 a lively account of the uses of statistics in government administration,† says that the detailed records of French imports and exports were begun as a result of the controversy in England at the time of the Peace of Utrecht.

From the time that William of Orange became ruler of England, trade between England and France has been rendered practically impossible by the restrictions and tariffs prevailing in both countries. Arnould says:‡

> "The Peace of Utrecht in 1713 gave birth to the hope of seeing the French and British markets opened to the merchants of the two nations. In fact, there was drawn up and signed on April 31 of that year, a treaty of commerce and navigation between the two powers. Immediately there arose in England two parties, one for retaining and one for rejecting these articles. The tables of importations and exportations between France and Great Britain were opened and commented upon in public discussions and the general opinion manifested caused the British Parliament to reject the treaty. It was at this period that the French Government, deprived of means of its own of combating the objections of the British commissioners and wishing to determine the advantage to their country of the articles which remained in force in the treaty, by an order in council of April 18, 1713, confirmed by a decree of June 16, 1716, confided to Sieur de Grandval the preparation of tables of importations and exportations from the information assembled in all the French customs houses. This was the origin of the 'Bureau de la Balance du Commerce' in France."

The "public discussions" to which Arnould refers were carried on in the columns of two English magazines, *The Mercator* and *The British Merchant.* Daniel Defoe described in *The Mercator* the beneficial character of the trade with France, and his opponent, in *The British Merchant*, charged "that as they who employed him (Defoe) and furnished him with Materials, had command of all the public papers in the Custom House, he had it in his Power to do a great deal of Mischief, among such as were unskilled in Trade, and, at the same time, very fond of French wine."§ As Arnould points out, "the British Merchant's" policy carried the day, and the almost prohibitive duties upon French goods remained.

The French records of foreign trade begun in 1716 were, like all other French state papers of that time, kept secret. No statement of French imports and exports was published until the Third Year of the French Republic, when Citizen Arnould, the last chief of the Bureau of the Balance of Trade under the old régime, printed foreign trade figures for France from 1716 to 1788 as an appendix to his book, *The Balance of Trade.** Arnould's figures are judged by French statisticians to be authoritative,† particularly as they are substantiated by statistics published in the August, 1830, number of the *Bulletin de la Société Française de Statistique Universelle.* This Bulletin gives‡ a recapitulation, "prepared from official documents by M. Cesar Moreau," of the value of French foreign trade from 1716 through 1829, with the exception of the years of the Revolution, 1789—97. From 1716 through 1789, the figures represent simply the value of the merchandise and specie imported and exported, and the trade of no one year is given separately, the years 1716 through 1720 being grouped together, and so on. A preliminary note states that "the figures for the first sixty years are taken from a manuscript belonging to M. Moreau, which was drawn up for the information of the King, Louis XVI, by M. Trudaine de Montigny, Chancellor of State, a magistrate distinguished for his learning, ability, and accuracy. The rest of the material is drawn from the best sources and for the last years is based upon official documents." For the years 1787, 1788, and 1789, and for each year from 1797 through 1829, the table presents the value of the specie and merchandise imported into and exported from France, giving separate figures for the trade in raw materials and manufactured articles.

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* *History of Statistics*, p. 268.

† *La Balance du commerce et des relations commerciales exterieures de la France* par le Cn. Arnould, Chef du ci-devant Bureau de la Balance du Commerce, l'an 3^{e} de la Republique.

‡ *La Balance du commerce*, p. 121, *et seq.*

§ Cunningham, *opus cit.*, pp. 462–3.

More detailed figures on early French trade are published in the *Commerce Exterieur*, the seventh volume of the *Statistique de la France* published by Le Ministre des Travaux Publics, de L'Agriculture et du Commerce in 1838. This publication gives (a) the value of the imports and exports of France by countries for 1787, 1788, 1789, 1792, and for each year from 1797 to 1810; (b) the value of the "general" commerce and the "special" commerce from 1815 to 1837, with separate figures for (1) the producers' and consumers' goods imported, separating the latter into natural and manufactured articles, and (2) for the raw materials and manufactured articles exported. In most cases where the figures given by the Department of Commerce cover the same years as those of M. Arnould and M. Moreau, they differ by several thousand francs. M. Faure is of the opinion that the unofficial figures are to be preferred. In 1823 the Direction Generale des Douanes was given the task of publishing trade statistics for France. The report of the annual trade for 1820 was the first volume to appear in this series which has been unbroken ever since.

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* I do not know how detailed Arnould's figures are. The only copy of *La Balance du Commerce* which I have been able to find is the one belonging to the Columbia University Library, and it lacks the third volume, the "Atlas" in which the tables are printed.

† *The History of Statistics*, p. 270.

‡ Pp. 12–13.

The progress of foreign trade statistics was not rapid in the eighteenth century, largely because of unsettled political conditions in Europe. Aside from England and France, only three countries had begun the regular compilation of their foreign trade statistics before the beginning of the nineteenth century—Portugal, Spain, and the United States of America.

In 1822 M. Adrien Balbi addressed to the King of France an *Essai Statistique sur la Royaume de Portugal et D'Algarin* in which he tells of his researches in Portuguese archives. "What was our astonishment to find," says he, "in a country hardly as advanced as Turkey, a general statement of commerce prepared annually from 1775 to the present by Chevalier Mauricio Teixeira Moraes, after a plan and with an exactitude that would be hard to find in the most civilized countries of Europe!"* In the course of his account of Portuguese industrial life, Balbi quotes tables of Portuguese foreign trade in 1796, 1806, and 1819, classified by countries and groups of commodities and expressed in value units, which are very satisfactory summary tables.†

When we consider how much of Spain's early wealth was the result of trade with her American colonies, it seems strange that she did not begin earlier to tabulate statistics on her overseas trade. Her method of levying customs duties varied greatly, but from 1624 to 1778, no declaration of exports from shippers was required and duties were levied on either the weight or the cubic measurement of the goods to be shipped, or the number of pieces in the cargo! Mr. C. H. Haring, writing in the Harvard Economic Series of *Trade and Navigation Between Spain and the Indies*, says of this rather remarkable practice: ‡

> "There is also a suspicion that there may have been another reason (than the desire to avoid unnecessary delay in shipments) for the opposition to a more exact appraisal of goods passing through the customs, for the Crown's willingness to trust to the good faith of the shipper. It was inconvenient to the Seville monopolists that exact knowledge of the cargoes sent to the great fairs at Porto Bello and Vera Cruz should become public. For, as the colonies were chronically undersupplied, the general level of prices at these fairs was governed by the comparatively simple procedure of balancing the whole value of the goods brought out with the whole amount of raw materials and bullion offered by the Creole merchants for exchange. And the Castilian exporters, by manipulating each year the nature and the quantity of the merchandise to be shipped to the Indies, raised prices at will and reaped enormous profits,

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* Vol. I, p. viii.

† Vol. I, p. 442.

‡ P. 91.

> said to have amounted to 300 or 400 per cent. It was a matter of some concern, therefore, that the character of the shipments should not be made known till the fleets reached their destination. And as the King was usually under obligation to the wealthy monopolists for gifts and loans to the exchequer, he was more apt to connive at practices of this sort."

Mr. Haring says* that this method of assessing customs duties remained in force until 1778. I judge that very shortly after that date the Spanish government began the regular compilation of the commodities entering into its foreign trade, for Alexandre Moreau de Jonnes, in his *Statistique de L'Espagne,* published in 1834, gives foreign trade figures for Spain from 1784 on, which came, he says, from unpublished official documents.†

Since the causes of the American Revolution, economic as well as political, were intimately bound up with foreign trade, it is not surprising that the second act of the first Congress of the United States authorized the Secretary of the Treasury to compile complete statistics of imports and exports. This is the more easily understood since the new government purposed to secure a good part of its revenue from taxation of the commodities imported into the country.

The first printed results of this act of 1789 were presented to the House of Representatives on February 15, 1791, by Alexander Hamilton as "a general return of the exports of the United States, abstracted from custom house returns, commencing on the various days in August whereon they were respectively opened, and ending on the 30th of September last." Hamilton was inclined to be apologetic about the period of time covered in the return. In his letter of transmittal to the speaker of the House, he wrote:‡

> "From inadvertence in some of these (custom) offices, the space of time prior to the 1st of October, 1789, was blended with the quarter following, which prevented a uniform commencement of this abstract on that day; and yet there is a deficiency for the last quarter of 1790 which confines the abstract to the 30th of September last."

In this first account of exports from the United States there is stated the total quantity and the total value of each commodity exported by countries, and the total value of the export trade to each country. The commodities enumerated are arranged partly in alphabetical order, the first five being

Potash
Pearlash
Apples
Boats
Bombshells

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* P. 92.

† "Nous en empruntos les chiffres a des documens officiel inedits." P. 159.

‡ American State Papers, Vol. VII, p. 23.

and partly in groups, as

- Fishery
  - Fish, dried pickled
  - Oil, whale spermaceti
  - Candles
  - Whalebone
- Grain
  - Buckwheat
  - Corn
  - Oats
  - Rice
  - Wheat
- Ginseng
- Gunpowder
- Gin
- Grindstones
- Hair Powder (*)

In this fashion there are presented the exports of 136 commodities to the following places:

- Great Britain
- France
- Spain
- Portugal
- Holland
- Flanders
- Germany
- Denmark
- Sweden
- Mediterranean
- Nova Scotia
- British West Indies
- French West Indies
- Dutch West Indies
- Spanish West Indies and Florida
- Swedish West Indies
- Portuguese Islands
- African Islands and the Coast of Africa
- East Indies
  (with an undivided total of ten thousand three hundred sixty-two dollars' worth to "the Northwest Coast of America")

The statement of imports into the United States for the year ending September 30, 1790, communicated to the Senate on November 18, 1791, is clearly the product of the tax-gathering organization of the government. It presents imports into the United States from thirty separate geographical divisions, distinguishing commodities from "England, Man and Berwick" from those from "Guernsey, Jersey, Sark and Alderney," but reporting those from "Africa generally" together. No details are given as to goods subject to duty ad valorem, other than the value of such goods from each country; and to the "enumerated goods paying a specific duty," which are stated in quantity units, no value is assigned. It is therefore impossible to arrive at the total value or the total quantity of imports into the United States for that year. Although a great many tables on foreign trade were submitted to Congress in the interim,[†] the first attempt to present the annual

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[*] American State Papers, Vol. VII, pp. 24–34.

[†] Under the title "The Statistical Work of the Federal Government," Julius H. Parmelee published in the *Yale Review* for November, 1910, the following unofficial sources of information on this period:

1. *A View of the United States of America*, published by Tench Coxe in 1794, giving official documents for 1790, 1791, and 1792.
2. *A Statistical Manual for the United States of America*, by Samuel Blodget, Jr., Washington, 1806.
3. *A Statistical View of the Commerce of the United States of America*, by Timothy Pitkin, Hartford, 1816. Many of the tables in this collection were obtained directly from the Treasury books, and had never been published.
4. *Statistical Annals* by Dr. Adam Seybert, covering the period 1789–1818, and giving statistics of population, commerce, public land, etc. Five hundred copies of this work were bought by Congress.

import and export statistics of the United States to the public in detailed and systematic fashion was made in February, 1821, when an act which provided for "obtaining accurate statements of the foreign commerce of the United States" was passed.

The first volume of the new series was entitled *Commerce and Navigation of the United States for the Year ending September 30, 1821.* It too was very evidently prepared by men whose interests were fiscal rather than commercial. The commodities entering into the import trade are classified by countries, and grouped as follows:

1. Value of merchandise free of duty
2. Value of merchandise paying duties ad valorem
3. Quantity and value of merchandise paying specific rates of duty

"The Goods, Wares, and Merchandise of the Growth, Produce and Manufactures of the United States Exported" are reported in quantity and value units, and classified by countries.

There had been no break in the series of annual foreign trade statistics for the United States since 1821, and there has been some improvement in the compilation and publication of the facts involved. In the years 1843–44, the fiscal year was changed from the year ending September 30th to that ending June 30th, and beginning with the volume for 1918, United States trade statistics have been compiled for the calendar rather than the fiscal year. The method of classifying the commodities exchanged has been radically reformed.

By the middle of the nineteenth century the publication of national import and export statistics had become the rule rather than the exception. In the Netherlands, a royal decree of 1825 called for the regular collection of data concerning imports, exports, and goods in transit, and commercial statistics were included in the Census of 1829.* Figures for Belgian trade date from the year of its winning independence; the first Belgian statistics published record trade facts for the years 1831–34.† Norway began the compilation of import and export statistics at the beginning of the nineteenth century, although no complete tables were published before 1835.‡ The Revenue Department of the Russian Empire also began to record trade figures not long after 1800, and early published a volume called *Foreign Commerce of Russia in its Principal Aspects.*§ In Denmark annual publication of foreign trade figures began in 1854,‖ and in Sweden in 1858.¶

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* *History of Statistics*, pp. 432–33.

† *Ibid.*, p. 143.

‡ *Ibid.*, p. 448.

§ *History of Statistics*, p. 509.

‖ *Ibid.*, p. 203.

¶ *Ibid.*, p. 556.

Until after 1871 the organization of trade statistics in Germany was difficult because of the lack of national unity. Some of the states of the Confederation of the Rhine published trade figures as early as 1812,* and the formation of the German Tariff Union in 1833, by its very nature necessitated trade statistics. It was natural, therefore, that very shortly after the formation of the German Empire (on March 9, 1872) a resolution was adopted founding an Imperial Statistical Office to prepare, among other things, statistics of foreign trade.†

Austria-Hungary began the annual compilation of *Tables of Statistics* (including figures on foreign trade) with the year 1828, but kept them secret until after the revolution of 1848–49. The 1850 volume of the *Tables*, which was made public property, includes trade statistics for the years 1845 and 1846.‡

In 1862 the Northern States of Italy were publishing trade figures for 1859, and the scope of these figures was gradually enlarged with the growth of the Kingdom of Italy.

In 1859 China began the publication of statistics on the Ports opened by Treaty, and in 1872 the first of the Japanese Political Tables were printed. Since England, France, and Germany (and in the case of the Philippines and Hawaii, the United States) have interested themselves in the compilation of trade statistics for most parts of Asia, Africa, and Oceania, it is safe to say that by the year 1900 the trade of almost every country in the world was being recorded in some fashion each year.

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* See *Statistik der Rheinbundstaaten*, Vol. I, pp. 323–25, and Vol. II, p. 262, pp. 240–41.

† *History of Statistics*, p. 337.

‡ *Tafeln zur Statistik*, 1850, Vol. II, Sec. 5.

A NEW MEASURE OF DISPERSION*

By Truman L. Kelley, *Stanford University*

The measures of dispersion in common use are: (1) the standard deviation; (2) average deviation; (3) quartile deviation; and (4) the range. It is generally admitted that the merit of the range as a measure of dispersion lies in its simplicity of determination and interpretation. To calculate its probable error has not been attempted; but were this done it would have little significance, for the range itself is not a constant function of a distribution, since, in general, it increases with an increase in population. The range is therefore unsatisfactory as a measure of dispersion, because it undoubtedly has a large probable error, and also because its significance varies as populations of different sizes are being considered.

The probable errors of the other three measures are given in the second column of the accompanying table. The values in columns 2 and 3 must be multiplied by the standard deviation of the distribution, and the values in columns 2 and 4 must be divided by the square root of the number of cases ($\sqrt{n}$) before they will serve in any particular problem. For purposes of comparison of different measures, these factors are here omitted.

TABLE

1 Measure of dispersion (D)	2 Probable error of measure of dispersion ($P.E._D$)†	3 Measure of dispersion in terms of the standard deviation‡ Range covered by measure in case of a normal distribution	4 The probable error of the measure of dispersion divided by the measure of dispersion§ $\left(\frac{P.E._D}{D}\right)$	5 Population necessary to secure a reliability equal to that of the standard deviation when determined from 100 cases
Standard deviation..........	0.4769*	1.0000	0.4769‡	100
Average deviation..........	0.4066	0.7979†	0.5096	114
Quartile deviation..........	0.5306	0.6745	0.7867	272
Range between percentiles:				
49 and 51..................	......	......	4.721	9798
45 and 55..................	......	......	2.036	1822
40 and 60..................	......	......	1.378	835
35 and 65..................	......	......	1.082	515
30 and 70..................	......	......	0.906	360
25 and 75..................	......	1.3490	0.787	272
20 and 80..................	......	......	0.702	216
10 and 90..................	......	2.5631	0.6001	158
7 and 93..................	......	2.9640	0.5905	153
5 and 95..................	......	3.2897	0.5964	156
2 and 98..................	......	......	0.665	196
1 and 99..................	......	......	0.756	251

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* Credit is due to William Betz and W. J. Osborn for the calculation of several of the probable errors reported in this article.

† The values in column 2 should be mutiplied by σ and divided by $\sqrt{n}$ to give the full definition.

‡ The values in column 3 should be multiplied by σ.

§ The values in column 4 should be divided by $\sqrt{n}$.

The formula used for the calculation of the probable error of (1) the standard deviation is $0.6745 \frac{\sigma}{\sqrt{2n}}$. The following formulas for the probable errors of (2) the average deviation and (3) the inter-percentile range have been derived by the writer from elementary principles:

(2) Probable Error of the average deviation equals $0.5096 \frac{A.D.}{\sqrt{n}}$.

(3) Probable Error of the inter-percentile range equals

$$0.6745\sqrt{\frac{np_1q_1}{y_1^2}+\frac{np_2q_2}{y_2^2}-\frac{2np_1q_2}{y_1y_2}}$$

in which p_1 and p_2 are the proportions lying below the percentiles studied; *e. g.*, if the probable error of the inter-quartile range is being determined, $p_1 = 0.25$ and $p_2 = 0.75$ (p_1 being always the smaller of these two proportions). The q's are defined by the usual relationship $p_1 + q_1 = 1$. Y_1 is the ordinate of the distribution at the p_1 percentile, and may be directly read from the distribution (preferably after slight smoothing), but if the normal distribution is assumed, it can be determined from Sheppard's tables of the ordinates of the normal probability integral.

In case it is desired to obtain the probable errors of distances between percentiles leaving equal amounts of area at each end of the distribution, the formula becomes for the normal distribution, $P.E._D = \frac{0.6745\sigma}{z\sqrt{n}}\sqrt{2p_1q_1 - 2p_1^2}$ in which D is the distance between the percentiles $100p_1$ and $100\ (1-p_1)$, σ is the actual standard deviation of the distribution, and z is the entry for the ordinate in Sheppard's tables corresponding to the proportion p_1. The formula for the probable error of this inter-percentile range is not in convenient shape for actual calculation, for it contains σ, which is usually unknown. As, however, the relationship between D and σ in the case of a normal distribution can be immediately obtained by referring to Sheppard's tables for any proportion, p, the formula can be readily transformed into one for practical application. In case $p_1 = .10$, so that D is the distance between the 10th and 90th percentiles, this formula becomes $P.E._D = \frac{0.6001}{\sqrt{n}}D$. Values for other inter-percentile ranges are given in column 4 of the table.

Empirical calculation in the case of a normal distribution of the probable errors of inter-percentile ranges in terms of their own magnitudes (such quantities as 0.6001 above) shows that the most reliable D for a given percentage difference, *i. e.*, for a given p_2-p_1 magnitude, is to be obtained when equal proportions are cut off at each end of the distribution, or, in other words, when $p_2=1-p_1$. Accepting this empirical finding as evidence of universal truth, the writer examined analytically ranges equally curtailed at the extremes. $\frac{P.E._D}{D}$ is the function which is desired to make a minimum. Differentiating this and setting the derivative equal to 0 and solving, results in the value $p_1=0.06917$ and $\frac{P.E._D}{D}=\frac{0.59053}{\sqrt{n}}$. Accordingly, if a distribution is normal, the most reliable inter-percentile range is found to be the range between 6.917 and 93.083. An examination of column 4 shows that the probable error of this range is not so much greater than that of the standard deviation as to make it an unserviceable measure, especially for rapid investigation or when percentiles must be calculated in any case.

In place of this 7 to 93 percentile range, practically nothing of reliability is lost if a slightly different range is used. Because of the very fortunate constant 0.6001, and because of the general necessity of knowing both the 10th and 90th percentiles if any percentiles at all are needed, it is herewith pointed out that the $10-90$ percentile range could to advantage be used in place of the semi-inter-quartile range or quartile deviation as a measure of dispersion. The relation in a normal distribution between this range and the quartile deviation is expressed by the equation $Q=0.26315\ D$; between this range and the standard deviation $\sigma=0.39015\ D$.

The properties of the $10-90$ percentile range here reported are based upon a normal distribution, but an examination of the general formula for the probable error of an inter-percentile range suggests that this $10-90$ percentile range is superior to the quartile deviation for practically all distributions. Comparatively it is more excellent for leptokurtic or peaked distributions, and slightly less excellent, though still much more reliable than the quartile deviation, for platykurtic or flat topped distributions.

The $10-90$ percentile range may readily be used as a basis for determining the existence of skewness and the nature of the kurtosis of a distribution. If the distribution is not skew, the average of the 10th and 90th percentiles will be equal to the median. The difference between the average of these two percentiles and the median is thus a measure of skewness. The probable error of this difference is equal to

$0.40412\frac{D}{\sqrt{n}}$. If the difference is small with reference to its probable error, skewness is not established.

Further, for a mesokurtic distribution, $Q=0.26315D$. Therefore, if $\frac{Q}{D}$ is <0.26315, the distribution is leptokurtic, and if $\frac{Q}{D}$ is >0.26315, the distribution is platykurtic. The probable error of $\frac{Q}{D}=\frac{0.18736}{\sqrt{n}}$.

The two formulas just given are based upon a normal distribution.

APPENDIX.

Derivation of formulas giving probable errors.

Let σ equal the standard deviation of the measure designated by the subscript.

σ without a subscript will stand for the standard deviation of the original distribution dealt with.

Let p equal the proportion of cases below a certain value P of the variate; accordingly the value of the $100p^{th}$ percentile is P.

Let q be defined by the usual relation $p+q=1$.

Let $Q=\frac{P_{75}-P_{25}}{2}$.

Let $D_{100p'-100p}=P_{100p}-P_{100p'}$.

Let D without subscript $=D_{10-90}=P_{90}-P_{10}$.

The following formulas are well known:

$$\sigma_p=\sqrt{\frac{pq}{n}}$$

$\sigma_P=\frac{1}{y_p}\sqrt{npq}$, in which y_p is the ordinate of the distribution at P, the $100p^{th}$ percentile.

$$\sigma_\sigma=\frac{\sigma}{\sqrt{2n}}$$

$r_{PP'}=\sqrt{\frac{pq'}{p'q}}$, in which $p<p'$.

APPENDIX A.

The calculation of the probable error of the average deviation.

The average deviation, or more exactly, the mean deviation, is the first moment of a distribution obtained by treating all the deviations from the mean of an original distribution as though positive. The mean deviation is thus the mean of a distribution of form like the half of a normal distribution and its standard deviation is to be obtained in exactly the same manner as the standard deviation of any other mean. Accordingly, $\sigma_{A.D.}=\sqrt{\frac{\bar{\mu}_2-\bar{\mu}_1^2}{N}}$, in which $\bar{\mu}_1$ and $\bar{\mu}_2$ are the first and second moments around an arbitrary origin. If moments around the stump of the half distribution are taken, they are moments around an arbitrary origin so far as the half distribution is concerned, though they are also moments around the mean of the total normal distribution. Accordingly $\bar{\mu}_2=\sigma^2$ and $\bar{\mu}_1=\frac{y_0\sigma}{.5N}$, in which y_0 is the ordinate of the normal curve at the mean. $\frac{y_0}{N}$ as found in Sheppard's tables $=0.3989$. Substituting and simplifying yields:

$$\sigma_{A.D.}=\frac{0.6028\sigma}{\sqrt{N}}=\frac{0.7555(A.D.)}{\sqrt{N}}$$

$$P.E._{A.D.}=\frac{0.5096(A.D.)}{\sqrt{N}}.$$

Appendix B.

The calculation of the probable error of an inter-percentile range.

$$\sigma D_{100p-100p'}=\sqrt{\sigma_P{}^2+\sigma_{P'}{}^2-2r_{PP'}\sigma_P\sigma_{P'}}=\sqrt{\frac{npq}{(y)^2}+\frac{np'q'}{(y')^2}-\frac{2npq'}{yy'}}.$$

If a normal distribution is assumed, each y is known when p is determined, and if $n=1$ and $\sigma=1$, y then becomes the ordinate z recorded in Sheppard's tables.

The reliability of a measure of dispersion is significant in terms of the magnitude of the measure, so that if the particular values of p and p' can be determined for which $\frac{\sigma_{D_{100p-100p'}}}{D_{100p-100p'}}$ is a minimum, the most reliable inter-percentile range will be found. Calculation of such ratios for a normal distribution shows that for a D of a given magnitude, or for a given $(100p-100p')$ magnitude, the ratio is always a minimum when $p=1-p'$. The writer has not proved this analytically, but empirical results warrant the generalization. It thus remains to determine the value of p for which the function, $f=\frac{\sigma_{D_{100p-100p'}}}{D_{100p-100p'}}$ is a minimum.

APPENDIX C.

The determination of the inter-percentile range having the minimal error.

It is desired to determine the value of D for which the function just given is a minimum. If x equals a deviation from the mean, then, assuming a normal distribution, $D=2x$, and the solution of the equation $\frac{df}{dx}=0$ will give the value of x and therefore of D and p for the inter-percentile range having the minimal error.

$$f=\frac{\sqrt{\frac{npq}{y^2}+\frac{np'q'}{(y')^2}-\frac{2npq'}{yy'}}}{2x}$$

$$y=\frac{1}{\sqrt{2\pi}}e^{\frac{-x^2}{2}};\quad p=\int_{-\infty}^{x} y\,dx;\quad n=1$$

y is the value tabled as z for different x's and p's in Sheppard's tables. If equal amounts are cut off at each end of the distribution then: $p=1-p'$; $p=q'$; $q=p'$; and $y=y'$; so that,

$$f=\frac{\sqrt{2p-4p^2}}{2xy}$$

$$\frac{df}{f}=\frac{d\sqrt{2p-4p^2}}{\sqrt{2p-4p^2}}-\frac{d(2x)}{2x}-\frac{dy}{y}.$$

Noting that $p<.5$, that $\frac{dp}{dx}=$y, and that $\frac{dy}{dx}=-xy$, the differential equation becomes:

$$\frac{df}{dx}=f\left[\frac{(1-4p)y}{2p-4p^2}-\frac{1}{x}+x\right].$$

Setting this derivative equal to zero and solving by the aid of Sheppard's tables yields $p=0.06917$, so that the minimal error inter-percentile range is that between the 6.917 and the 93.083 percentiles.

APPENDIX D.

The calculation of the probable error of the difference between the P_{50} and the average of the P_{10} and P_{90} percentiles.

Let $f=P_{50}-\frac{1}{2}(P_{90}+P_{10})$

$\Delta f=\Delta P_{50}-\frac{1}{2}\Delta P_{90}-\frac{1}{2}\Delta P_{10}$.

Squaring, summing, and as a first approximation setting $\sigma_f{}^2=\frac{\Sigma(\Delta f)^2}{N}$,

$\sigma_{P_{50}}{}^2 = \frac{\Sigma(\Delta P_{50})^2}{N}$, etc., gives,

$$\sigma_f{}^2 = \sigma_{P_{50}}{}^2 + \tfrac{1}{4}\sigma_{P_{90}}{}^2 + \tfrac{1}{4}\sigma_{P_{10}}{}^2 + \tfrac{1}{2} r_{P_{90}P_{10}}\sigma_{P_{90}}\sigma_{P_{10}} - r_{P_{50}P_{90}}\sigma_{P_{50}}\sigma_{P_{90}} - r_{P_{50}P_{10}}\sigma_{P_{50}}\sigma_{P_{10}}.$$

Simplifying, $\sigma_f = 1.53567\ \frac{\sigma}{\sqrt{n}} = 0.599143\ \frac{D}{\sqrt{n}}$

$$P.E._f = 0.40412\ \frac{D}{\sqrt{n}}.$$

Appendix E.

The calculation of the probable error of the quotient $\frac{Q}{D}$.

Let $f = \frac{Q}{D}$

$$\frac{df}{f} = \frac{dQ}{Q} - \frac{dD}{D}$$

$\frac{\sigma_f{}^2}{f^2} = \frac{\sigma_Q{}^2}{Q^2} + \frac{\sigma_D{}^2}{D^2} - 2r_{QD}\frac{\sigma_Q\sigma_D}{QD}$, in which r_{QD} may be shown $\text{to} = 0.5$.

Simplifying,

$\sigma_f = 0.27779\frac{1}{\sqrt{n}}$, or

$$P.E._{\frac{Q}{D}} = 0.18736\frac{1}{\sqrt{n}}.$$

OCCUPATIONS OF IMMIGRANTS BEFORE AND AFTER COMING TO THE UNITED STATES

By Louis Bloch*

INTRODUCTION

In this article are set forth the results of an effort to learn the extent to which the immigrant, after coming to this country, utilizes his previous experience as an industrial or agricultural worker. Does a carpenter from the old country, for instance, work in this country as a carpenter, or does he find employment in some other occupation in which he cannot utilize his trade experience? Similarly, to what extent do agricultural laborers and farmers from the old country find agricultural employment in this country? As will be seen from the following pages, the problem does not lend itself to an easy solution.

The data used in the investigation were drawn from the following sources: (1) the reports of the United States Immigration Commission; (2) the United States censuses of 1880, 1890, 1900, and 1910; and (3) the reports of the Commissioner General of Immigration.

One of the difficulties encountered in the use of the census data was a perplexing lack of uniformity of occupational designations. To make matters somewhat more complicated, the occupations of arriving immigrants, as given in the reports of the Commissioner General of Immigration, are not classified in such a way as to make them readily comparable with the occupation groups of any of the censuses referred to. Owing to this lack of uniformity in classification of occupations, it was found to be impossible to include more than a few occupations.

In studying the data presented below, it should be remembered that the number of arriving immigrants reported does not represent the *net* increase of immigrants in the respective occupations. To secure the net increase it is necessary to deduct from the total arrivals the total number of immigrants in the respective occupations who departed during the decades studied. Owing to the fact that no figures for departing emigrants appear in the reports of the Commissioner General of Immigration until 1908, it is impossible to get at the exact increase of the occupational groups studied. Beginning with 1908, the number of departing immigrants, by occupation, is given annually in the reports of the Commissioner General of Immigration.

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* In the preparation of this article the writer received valuable suggestions from Dr. C. C. Williamson, Statistician for the Carnegie Americanization Study. This article was originally prepared for the members of the staff of the Carnegie Americanization Study and appeared as Bulletin No. 32 (mimeographed) of its Division of Information.

It was found desirable to divide the study into two sections, one dealing with agricultural laborers and farmers, the other with skilled industrial workers.

SECTION I

FOREIGN-BORN AGRICULTURAL LABORERS AND FARMERS IN THE UNITED STATES

It is generally conceded to be a fact that a considerable majority of immigrant agricultural laborers and farmers do not find employment in agricultural pursuits in the United States. A statement to the effect that not one in ten immigrant agricultural laborers settles on a farm in this country is found in the *Immigration Problem* by Jenks and Lauck (edition of 1917, p. 100). In his report on immigration to the United States Industrial Commission of 1900, Professor Commons says it is certain that a large proportion of immigrant *laborers* and *farm laborers* destined for Pennsylvania in 1900 found employment in the mines of that state.*

The following table (Table I) shows that in the year 1900 there were 259,294 foreign-born whites of both sexes engaged as farm laborers in this country. In 1910 the number of foreign-born white farm laborers was 336,753, an increase of 77,459 or 29.9 per cent. According to the reports of the Commissioner General of Immigration, 1,602,743 immigrant agricultural laborers, male and female, arrived in the United States between 1901 and 1910, both dates inclusive. From 1908 to 1914, however, 1.9 per cent as many farm laborers went back as came in, according to the report of the Commissioner General of Immigration. On this basis the net addition to the farm laborers may be estimated at 1,572,291. If all of these had actually engaged in agricultural pursuits in this country, the increase would have been 606 instead of 29.9 per cent. The per cent of farm laborers departing again must have been much larger than reported. The occupation given on departure is apparently that followed in this country, so that many whose training and experience in the old country were in agriculture return as skilled or unskilled workers in other occupations. In the years 1908–1914 the total number of departing immigrants amounted to 36.2 per cent of all arrivals. For skilled occupations, as indicated in Table V, the proportion of those going back is only about one-third as great (13.3 per cent for sixteen skilled occupations) as for all occupations. It is evident, therefore, (1) that the per cent of farm laborers going back to the old country is larger than the per cent of those returning in all occupations, and (2) that returning immigrants report the occupation they followed in this country. Instead of 1.9 per cent of those who came in as farm laborers returning to the old country, an estimate of 50 per cent would probably be conservative. Assuming, therefore, that as many as half of the agricultural laborers returned, the increase in foreign-born farm laborers would have been over 300 per cent instead of 29.9 if they had all followed their former occupations. The actual increase was 77,459; the net addition by immigration is estimated at 801,371. Consequently, it would seem that not more than 10 per cent of immigrant farm laborers go into agricultural pursuits in this country.

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* Vol. 15, p. 389.

TABLE I

NUMBER OF FOREIGN-BORN WHITES ENGAGED AS FARM LABORERS IN THE UNITED STATES, BY SEX: 1900 AND 1910

(U. S. Census of 1910, vol. IV, p. 303; U. S. Census 1900, Special Report on Occupations 1904, p. 11)

Sex	1910	1900	Increase 1900 to 1910
Males...................	308,360	253,895	21.5
Females.................	28,393	5,399	425.9
Both sexes..............	336,753	259,294	29.9

The Immigration Commission made a detailed study of 17,141 households, the heads of which were miners or wage-earners in manufacturing establishments. Table II shows that of the persons of these households for whom complete data were secured, 62 per cent of the males and 24.3 per cent of the females were employed as farm laborers or as farmers before coming to the United States. Table III shows

TABLE II

OCCUPATIONS BEFORE COMING TO THE UNITED STATES OF FOREIGN-BORN MALES AND FEMALES WHO WERE 16 YEARS OF AGE AND OVER AT TIME OF COMING

(From Reports of Immigration Commission, vol. 19, pp. 89, 93, Study of Households)

Number reporting complete data	Per cent without occupation	Per cent working for wages				Per cent working without wages		Per cent working for profit	
		Farm laborers	General laborers	Domestic service	All other occupations	Farm laborers	All other occupations	Farmers	All other occupations
Males 21,696	3.2	20.3	2.9	....	27.8	28.6	.9	13.1	3.0
Females 13,315	59.7	7.3	....	8.4	6.8	16.4	.5	.6	.4

that of the members of the same households for whom complete data were secured, 0.1 per cent of the males and less than 0.05 per cent of the females were employed in agricultural pursuits in this country. It should be remembered, however, that the households studied by the Immigration Commission were those whose heads were engaged as miners or wage-earners in manufacturing establishments; consequently, it should not be expected that any considerable proportion of the members of these households would be employed in agricultural pursuits.

TABLE III

PER CENT OF FOREIGN-BORN MALES AND FEMALES 16 YEARS OF AGE AND OVER ENGAGED IN SPECIFIED INDUSTRIES

(From Reports of Immigration Commission, vol. 19, pp. 101–102, Study of Households)

Number reporting complete data	Agricultural pursuits	Domestic and personal services	Manufacturing and mechanical pursuits	Mining	General labor	Professional services	Trade	Fishing	At home	At school	Trans portation	Total
Males 25,727	.1	.8	67.9	25.0	1.3	.1	1.1	(*)	2.5	.2	1.0	100.0
Females 17,117	(*)	2.1	16.5	(*)	(*)	(*)	.5	.0	80.3	.4	(*)	99.8

* Less than 0.05 per cent.

The Immigration Commission also secured detailed information from groups of employees in mines and manufacturing establishments. Table IV shows that of the 181,330 male employees reporting complete data the larger proportion, about 54 per cent, were employed in the old country in farming or as farm laborers, while of the 12,968 female employees reporting complete data, 44 per cent were employed in the old country in farming or as farm laborers.

TABLE IV

PER CENT OF FOREIGN-BORN EMPLOYEES IN SPECIFIED OCCUPATIONS BEFORE COMING TO THE UNITED STATES

(From Reports of Immigration Commission, vol. 19, pp. 95–98, Study of Employees)

Number reporting complete data	In manufacturing	Farming and farm labor	General labor	Domestic service	Sewing, embroidery and lace making	Teaching	Trade	Other occupations	Total
Males 181,330	15.3	53.9	10.3	....	....	....	2.5	18.1	100.1
Females 12,968	32.5	44.2	....	6.2	13.4	.7	1.8	1.4	100.2

SECTION II

HOW SKILLED IMMIGRANT WORKERS ARE EMPLOYED IN THE UNITED STATES

The data presented in the first part of this article show that a considerable majority of immigrant agricultural laborers and farmers do not follow their former occupations after coming to the United States. It was shown that of the members of the households studied by the Immigration Commission 62 per cent of the males and about 24 per cent of the females had been engaged as agricultural laborers and farmers in the old country; while in this country they were mainly employed in manufacturing and mining. It is apparent that any skill or experience in agricultural pursuits which these immigrants may have possessed is largely unutilized in this country. An analysis of the available data relating to skilled immigrant workers shows that a similar situation exists with regard to this class of foreign-born labor.

Table IV, based upon a study of employees engaged in this country in manufacturing and mining, shows that only 15.3 per cent of the males and 32.5 per cent of the females had had any experience in manufacturing before coming to the United States. It is evident, therefore, that about 84 per cent of the males and about 67 per cent of the females in this group were not utilizing such skill and experience as they may have acquired in the occupations they had been engaged in before coming to the United States.

The difficulties met with in attempting to compare the census data for specific occupations for the years 1900 and 1910 have been referred to above. After making a careful examination of all the occupational groups, sixteen have been selected for which the figures seem to be reasonably comparable for the two censuses. For these sixteen occupations, therefore, an effort has been made to learn what light the available statistics throw on the utilization of the immigrant's industrial skill and experience.

The method adopted is to compare the increase or decrease in the number of foreign-born reported for each occupation in 1910 with the number of immigrants belonging to the same occupation who arrived during the decade, as reported by the Bureau of Immigration. The result at best can be regarded as only approximately accurate. It is evident, however, that it is those who remain in the United States and not the total number of those who arrive that must be regarded as the new additions in each occupation.

As pointed out above, statistics of departures are not available prior to 1908, so that the number of foreign-born in each occupation returning during the decade can only be estimated. Comparing the figures for arrivals and departures in each of the selected occupations during the period 1908–14, inclusive, it is found that 13.3 per cent of all who came went back to the old country, but that the per cent of departures varies greatly for the different occupations. Accordingly, in Table V the net addition of foreign-born in each occupation is found by deducting from total arrivals in the decade the per cent of departures in the years 1908–14. This process involves a slight error, varying in importance with the different occupations, since no account is taken of the fact that a certain number of those departing under one occupation classification came in under another. No estimate of the number of such cases can be given. Table V, therefore, assumes that all immigrants reported on departure the same occupation they gave on arrival. The result is that our estimate of the per cent of immigrants who abandon their former occupations (Table V, column 9) after reaching the United States is an under-estimate, for the reason that it includes only those who remained in the country.*

Table V summarizes the available data in regard to (1) the actual increase in the number of foreign-born engaged in each of the sixteen selected occupations, according to the census figures, and (2) the net additions to each of the sixteen occupations which could have resulted from immigrants arriving during the decade 1900 to 1910.

Special attention may be called to the facts revealed in Table V for each of the sixteen selected occupations. The table shows that in 1910 there were 5,964 more foreign-born white bakers than in 1900, an increase of 13.8 per cent. If all the bakers who arrived during the decade 1901–10, less the 15.2 per cent estimated to have returned in the same period, had followed their former occupation, the increase from 1900 to 1910 would have been 69.8 per cent. These figures seem to show that about 80 per cent of the bakers who arrived and remained in the United States between 1901 and 1910 went into other occupations.

In discussing the difficulties of classifying occupations, the census of 1910 (Vol. IV, p. 21) calls attention to the fact that in common with several other occupations, the number of bakers reported is excessive. The reason given is that " . . . in all those cases in which hand trades, through the introduction of machinery, the multiplication of processes, and the division of labor, have rather recently developed into factory industries, there was a marked tendency for the operatives to give the old trade names as their occupations, rather than the names

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* This under-estimate is counterbalanced by the fact that no account is taken of the mortality rates in the respective occupations. Assuming a death-rate of twenty per cent in a decade for each occupation, the percentages of immigrants who abandoned their former occupations (Table V, col. 9) would be reduced by about twenty per cent. This, however, would not vitiate the general conclusions arrived at.

TABLE V

FOREIGN-BORN WHITES, BOTH SEXES, ENGAGED IN SPECIFIED OCCUPATIONS IN 1900 AND 1910, INCREASE 1900 TO 1910, AND THE NUMBER OF WHITE IMMIGRANTS ARRIVING AND REMAINING IN THE UNITED STATES DURING 1901–10; AND THE PER CENT ESTIMATED TO HAVE ABANDONED THEIR FORMER OCCUPATIONS

Occupations	Number engaged		Increase (or decrease) from 1900 to 1910		Number arriving 1901–10	Per cent departing 1908–14	Number remaining from those who arrived 1901–10	Number remaining 1901–1910, expressed as per cent of total enumerated in 1900	Per cent of immigrants who abandoned their former occupations, 1901–10
	1900 (1)	1910 (2)	Number (3)	Per cent (4)	(5)	(6)	(7)	(8)	(9)
Sixteen occupations	547,072	725,790	100,518	....	489,503	13.3	424,399	73.9	76.3
Bakers	43,368	49,332	5,964	13.8	35,707	15.2	30,280	69.8	80.3
Barbers and hairdressers	34,595	53,431	18,836	54.4	24,056	20.9	19,028	55.0	1.0
Blacksmiths	62,950	66,956	4,006	6.4	44,637	9.8	40,263	64.0	90.1
Bookbinders	5,911	5,356	−555	−9.4	4,359	5.4	4,124	69.8	100.0
Cabinetmakers	20,119	23,764	3,645	18.1	6,489	24.4	4,906	24.4	25.7
Carpenters and joiners	152,897	213,788	60,891	39.8	126,830	14.9	107,932	70.6	43.6
Engravers	2,916	3,214	298	10.2	1,239	13.0	1,078	37.0	72.4
Leather curriers and tanners	19,909	6,591	−13,318	−66.9	6,240	9.6	5,641	28.3	100.0
Marble and stonecutters	24,312	17,798	−6,514	−26.8	16,057	18.6	13,070	53.8	100.0
Masons	56,898	75,840	18,942	33.3	68,054	12.8	59,343	104.3	68.1
Painters, glaziers, and varnishers	65,188	82,567	17,379	26.7	33,027	12.1	29,031	44.5	40.1
Plasterers	9,218	14,368	5,150	55.9	4,926	20.9	3,896	42.3	0.0
Plumbers, gas and steam fitters	18,717	29,849	11,132	59.5	4,899	11.3	4,345	23.2	0.0
Printers, lithographers, and pressmen	23,290	22,625	−665	−2.9	7,583	10.5	6,787	29.1	100.0
Shoemakers and bootmakers	75,266	55,137	−20,129	−26.7	99,663	10.3	89,398	118.8	100.0
Saddlers and harness makers	9,718	5,174	−4,544	−46.8	5,742	4.7	5,472	56.3	100.0

of specific processes they were performing." Consequently, there were undoubtedly in 1910 somewhat less than 49,332 foreign-born white bakers, for a large proportion of those who called themselves bakers were merely performing some specific process in which they did not utilize to the full extent their experience and training as bakers in the old country. Another factor here to be taken into consideration is that the introduction of machinery, the multiplication of processes, and the division of labor have made it possible for immigrants who formerly followed other occupations to become bakers. The increase of 5,964 foreign-born white bakers from 1900–1910 may therefore be due in part to foreign-born white workers of other occupations becoming bakers.

Of foreign-born white barbers and hairdressers there were 18,836 more in 1910 than there were in 1900, an increase of 54.4 per cent. Assuming that 20.9 per cent of all barbers and hairdressers who arrived during the decade left the country again and that those remaining all engaged in their former occupations the increase would have been 55 per cent. We may infer, therefore, that the increase of foreign-born white barbers and hairdressers from 1900 to 1910 was derived largely from immigrants of the same occupation who arrived during the decade and that a small number of the new immigrants went into other occupations.

In 1910 there were 66,956 foreign-born white blacksmiths, which represents an increase of 4,006, or 6.4 per cent, over 1900. During the years 1901 to 1910, inclusive, 44,637 white immigrant blacksmiths arrived in the United States. Assuming that 9.8 per cent of these left the country again, the increase of foreign-born white blacksmiths from 1900 to 1910 would have been about 64 per cent. In other words, only about 10 per cent of the blacksmiths assumed to have remained in the United States followed their former occupations.

There were 555 foreign-born white bookbinders less in 1910 than there were in 1900, a *decrease* of 9.4 per cent. If of the 4,359 bookbinders who arrived during the decade, 94.6 per cent, or 4,124, had followed their former occupations in the United States, the *increase* over 1900 would have been about 69.8 per cent.

Foreign-born cabinetmakers in 1910, as compared with 1900, showed an increase of 3,645, or 18.1 per cent. If 75.6 per cent of all the arriving cabinetmakers had followed their former occupations, the increase would have been about 24.4 per cent. Assuming that the increase was composed entirely of immigrants who had been cabinetmakers abroad, it appears that nearly 26 per cent of the cabinetmakers supposed to have remained in this country engaged in other occupations.

In 1900 there were 152,897 foreign-born white carpenters and joiners. In 1910 the number had increased to 213,788, including 566 carpenters' apprentices and 1,605 carpenters' helpers. The figure for 1900 probably also includes apprentices and helpers. The increase in 1910 over 1900 was 60,891, or 39.8 per cent. If of the 126,830 immigrant carpenters and joiners who arrived during the decade only 85.1 per cent, or 107,932, remained and followed their former occupations, the increase in 1910 over 1900 would have been 70.6 per cent. If the increase of 60,891 in 1910 over 1900 was composed entirely of immigrants who were carpenters and joiners abroad, and if of all the incoming immigrant carpenters and joiners only 107,932 remained, then only 56.4 per cent of all those who remained engaged in their former occupation.

Of foreign-born white leather curriers and tanners there were apparently 13,318 less in 1910 than there were in 1900, a decrease of 66.9 per cent. It appears that not only have the incoming leather curriers and tanners failed to take up their former occupations, but the larger proportion of those who in 1900 followed that occupation abandoned it between 1900 and 1910. It is probable that the marked decrease in this occupation is due to the fact that the census of 1910, as has been mentioned above, aimed to record the specific operation performed rather than the trade of the informant, so that those who were returned in 1900 as tanners were returned in 1910 under such occupations as "setters-out," "sorters," "shavers and scrapers," "splitters," "scrapers," etc. It is not possible, therefore, to compare the number of foreign-born whites engaged in tanneries in 1910 and in 1900. If this comparison were possible and if it were to show an increase in the total number of foreign-born whites employed in tanneries proportionate to the number of leather curriers and tanners who arrived during the decade, it still would not follow that the increase consisted of immigrants who were leather curriers and tanners abroad, or that if the increase did consist of these workers, they were utilizing the same degree of skill and experience required abroad in the same occupations.

The foreign-born marble and stone cutters also show a marked decrease in 1910 as compared with 1900. The 16,057 immigrant marble and stone cutters who arrived during the decade 1901–1910 had apparently no effect upon the number of foreign-born white marble and stone cutters in 1910.

The foreign-born white masons show an increase of 33.3 per cent in 1910 over 1900. If 87.2 per cent of all the white immigrant masons who arrived during the decade had remained in the United States and followed their former occupations, the increase in 1910 over 1900 would have amounted to 104.3 per cent.

The 82,567 painters, glaziers, and varnishers in 1910 includes 215 apprentices and 368 helpers, as well as 723 workers designated in the census of 1910 as "painters and gilders." The increase in 1910 as compared with 1900 was 26.7 per cent. If of the 33,027 painters, glaziers, and varnishers who arrived during the decade, 29,031, or 87.9 per cent, had remained and followed their former respective occupations, the increase in 1910 over 1900 would have been 44.5 per cent.

In 1910 there were 14,368 foreign-born white plasterers. This number includes 86 apprentices and 874 helpers. In 1900 the number of foreign-born white plasterers was 9,218, an increase of 55.9 per cent. If only 79.1 per cent of the incoming immigrant plasterers had remained in the United States and worked as plasterers, the increase would have been about 42.3 per cent. These figures seem to show that immigrants who followed other occupations (or no occupations) before coming into the United States became plasterers after their arrival in this country.

In 1900 there were 18,717 plumbers, gas and steam fitters, while in 1910 there were 29,849. Of this number 628 are given in the census of 1910 as plumbers' apprentices and 2,422 as plumbers' helpers. Since the 1910 census does not classify separately gas and steam fitters, it has been assumed here that these occupations were included under plumbers. The increase in 1910 over 1900 is 59.5 per cent. If the increase had consisted only of arriving plumbers, gas and steam fitters who remained in this country and had followed their former occupations, the increase would have been only 23.2 per cent. In this case, as in the case of the plasterers, it appears that immigrants who formerly, in the old country, followed other occupations became plumbers, gas and steam fitters in this country.

In 1900 there were 23,290 printers, lithographers, and pressmen. In 1910 there were 22,625, including 17,617 workers designated as compositors and typesetters, and 225 workers designated as press hands. During the decade 7,583 printers arrived. No separate class appears in the reports of the Commissioner General of Immigration for lithographers and pressmen, or presswomen. The decrease in this occupation was 2.9 per cent, though if all the arriving immigrant printers who remained had followed their former occupations, there would have been an increase of 29.1 per cent. Apparently, then, the immigrant printers who came to the United States during the decade took up other occupations.

Of the 55,137 shoemakers reported in 1910, 44,802 were not engaged in factories, while 10,335 were designated as shoemakers (not specified) in factories. Compared with 1900, the figure for 1910 represents a decrease of 20,129, or 26.7 per cent. If the 89,398 arriving immigrant shoemakers who remained in the United States had followed their former occupation, there would have been an increase of 118.8 per cent. It appears, then, that the old country shoemaker drifts into some other occupation after his arrival in the United States; or if he finds employment in a modern shoe factory, he specializes in some specific process requiring little or none of the skill he possessed as shoemaker at home.

It is seen that in 1910 there were 4,544 saddlers and harness makers less than there were in 1900, a decrease of 46.8 per cent. If, however, all the immigrant saddlers and harness makers who arrived in this country during the decade and remained had followed their former occupation, 1910 would show an increase of 56.3 per cent over 1900.

It will be seen that of all the occupations considered, the plasterers, and the plumbers, gas and steam fitters, are the only groups which seem to have absorbed the total net immigration. The total number of immigrants in the sixteen occupations assumed to have remained here was 424,399, while the net increase of foreign-born in all the occupations considered was 100,518. In other words, taking these sixteen skilled occupations as a whole, only 23.7 per cent of those who came to the United States and did not return took up their former occupation; 76.3 per cent scrapped their skill and experience and took up some other trade.

Table VI shows the distribution of immigrants in nine industrial and two professional occupations for the decade 1880–90. This period was chosen rather than 1890–1900 because comparable data could not be secured for the latter. It will be seen that the immigrant clergymen, physicians and surgeons, carpenters and joiners, machinists, and tailors were fully absorbed by their former occupations, while the bakers, the blacksmiths, the butchers, the shoemakers, and the masons were not.

It should be pointed out that no reliable data are available as to the number of immigrants of each occupation returning during the decade 1880–90. It has been assumed that the proportion is the same as in the period 1908–14, though this is probably an overestimate. In Table VI as in Table V it is assumed that the increase in the respective occupations during the decade came entirely from new immigrants who had followed the same occupations abroad. On this basis it appears that the proportion of immigrants who abandoned their former occupations varied from zero in several cases to 65.7 per cent in the case of the shoemakers. The large increase of foreign-born machinists seems to indicate that the census returns included a considerable number of helpers and apprentices and perhaps other employees in machine

TABLE VI

FOREIGN-BORN, BOTH SEXES, ENGAGED IN SPECIFIED OCCUPATIONS IN 1880 AND IN 1890, INCREASE 1880 TO 1890, THE NUMBER OF IMMIGRANTS ARRIVING AND THE ESTIMATED NUMBER REMAINING IN THE UNITED STATES DURING THE DECADE 1880-1890, AND THE PER CENT ESTIMATED TO HAVE ABANDONED THEIR FORMER OCCUPATIONS

(From U. S. Census 1880, vol. 10, pp. 744-51; U. S. Census 1900; special report on occupations pp clxxxvii-clxxxix; Report of Commissioner General of Immigration 1892, pp. 44-50.)

Occupation	Number engaged		Increase 1880-1890		Number arriving 1881-1890	Per cent departing 1908-1914	Number remaining from those who arrived 1881-1890	Number remaining 1881-1890, expressed as per cent of total enumerated in 1880	Per cent of immigrants who abandoned their former occupations 1881-1890
	1880	1890	Number	Per cent					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Total of eleven occupations	540,470	830,584	290,114	....	279,485	25.1	209,334	38.7	0.0
Clergymen	12,731	18,387	5,656	44.4	3,534	27.2	2,573	20.2	0.0
Physicians and surgeons	8,579	11,185	2,606	30.3	2,253	31.4	1,546	18.0	0.0
Bakers	23,201	35,117	11,916	51.3	18,674	15.2	15,836	68.3	24.8
Blacksmiths	47,130	64,851	17,721	37.6	27,405	9.8	24,719	53.4	28.3
Butchers	29,230	38,993	9,763	33.4	17,799	12.6	15,556	53.2	37.2
Carpenters and joiners	85,691	160,006	74,315	86.7	64,468	14.9	54,862	64.0	0.0
Miners	126,235	195,439	69,204	54.8	49,091	117.8	......	....	....
Shoemakers	69,388	78,150	8,762	12.6	28,481	10.3	25,547	36.8	65.7
Machinists	30,458	57,457	26,999	88.6	3,634	30.2	2,537	8.3	0.0
Masons	36,246	60,867	24,621	67.9	30,418	12.8	26,524	73.2	7.2
Tailors	71,581	110,132	38,551	53.8	33,728	11.1	29,984	41.9	0.0

shops who were not skilled machinists. It is evident that a large number of immigrants previously engaged in other occupations during the decade 1880–90 entered such professions and occupations as clergymen, physicians and surgeons, carpenters and joiners, miners, machinists, and tailors.

The Immigration Commission in its study of immigrants in industry made inquiry as to the occupation and experience of the foreign-born before coming to this country. The results of this inquiry are presented in Table VII. The most striking fact revealed is the very small per cent of employees in certain industries who had been employed in the same occupation abroad. The proportion of farm laborers is high, but perhaps not so high as might be expected.

TABLE VII

EMPLOYEES AND HOUSEHOLDS STUDIED BY THE IMMIGRATION COMMISSION IN FIFTEEN PRINCIPAL INDUSTRIES, THE PROPORTION OF THE EMPLOYEES WHO WERE FOREIGN-BORN AND THE PERCENTAGES OF THE FOREIGN-BORN WHO HAD BEEN EMPLOYED AT THE SAME OCCUPATIONS OR HAD BEEN FARMERS OR FARM LABORERS ABROAD, BY INDUSTRY AND SEX

(From Abstracts of Reports of the Immigration Commission, vol. 1, pp. 297–313)

Industry	Number of employees from whom detailed information was secured	Number of households studied	Per cent of employees foreign-born	Per cent of foreign-born employees at same occupation abroad			Per cent of foreign-born employees who were farmers or farm laborers abroad		
				Male	Female	Both sexes	Male	Female	Both sexes
Iron and steel	86,089	2,456	57.7	....	....	8.6	....	....	64.4
Slaughtering and meat packing	43,502	1,039	60.7	5.1	0.5	....	58.4	82.8	....
Bituminous coal mining	88,368	2,371	61.9	....	....	20.7	....	....	58.0
Woolen and worsted mfg.	23,388	440	61.9	22.1	41.9	....	42.4	34.5	....
Silk goods mfg. and dyeing	12,994	272	34.3	73.9	76.1	....	6.5	7.5	....
Cotton goods mfg.	66,800	1,061	68.7	15.8	34.5	....	56.2	50.7	....
Clothing mfg.	19,502	906	72.2	62.5	75.6	....	....	....	....
Boots and shoes	19,946	710	27.3	....	....	41.4	....	....	29.2
Furniture mfg.	4,295	338	59.1	....	....	10.4	....	....	49.3
Collar, cuff and shirt mfg.	1,508	264	13.4	....	3.6	....	....	35.7	....
Leather, tanning, currying and finishing	12,839	362	67.0	....	....	6.0	....	....	58.1
Glove mfg.	908	262	33.5	60.9	14.4	....	21.2	5.5	....
Oil refining	6,123	525	66.7	0.0	0.0	....	....	....	60.8
Sugar refining	5,826	194	85.3	....	....	0.6	....	....	60.8
Cigars and tobacco	35,564	127	32.6	55.3	29.2	....	23.3	51.6	....

CONCLUSION

Although the lack of uniformity of occupational designations and the absence of satisfactory information with regard to the number of departing immigrants and their occupations make it impossible to take the above figures literally, the available statistics do, nevertheless, seem to show definitely that on the whole neither the immigrant agricultural workers nor the immigrant skilled workers follow their former occupations to a large extent after coming to the United States. The fact that many occupations show an increase of foreign-born entirely disproportionate to the number of immigrants of the same occupation who came into the country, indicates that immigrants choose an occupation without much regard to their previous training and experience. This fact also suggests that special skill and training are not generally required of immigrants. It is probable that in occupations showing a disproportionate increase of foreign-born the immigrants in reality perform specific processes, though still parading under the general trade name. The large increase of tailors from 1880 to 1890, for example, shows that many immigrants learned the tailoring trade in this country in a much shorter time than it would have taken them to learn the same trade abroad. The division of labor and the multiplication of machinery referred to above have made it possible for many trades to employ immigrants regardless of their former training and experience and have probably, on the other hand, compelled many immigrants to abandon their previous occupations.

It has not been assumed in this study that it is to the best interests of the foreign-born or of society for the immigrant to engage in this country in the same occupation he followed abroad. Many immigrants leave the old country with the hope of finding in America an occupation more suitable for their health or tastes; others for the purpose of finding more lucrative employment.

If each skilled occupation in this country pays better wages than the corresponding occupation in the old country, it becomes necessary to regulate the influx of immigrants in these occupations in order to keep up the better wage. If this regulation is to be accomplished by those already in the trade, it probably requires a closed shop to exclude the new immigrant, thus compelling him to seek employment in another trade.

It is probable, by reason of our specialized industrial processes, that the number of skilled immigrant workers coming into this country is in excess of the number needed. From a social point of view, therefore, it need not follow that the skilled immigrant workers should engage in occupations which would enable them to utilize their acquired trade skill and training, or that skilled immigrants are more desirable than unskilled.

The fact, for instance, that apparently none of the 89,398 shoemakers who arrived during 1900–1910 and are assumed to have remained in the United States, engaged in their former occupations may be to the best interests of the shoemakers themselves as well as to the best interests of the country. The figures (Table V) show that there was a decrease of foreign-born boot and shoemakers in 1910 as compared with 1900, amounting to about 27 per cent. If all the new shoemakers had found employment as shoemakers, there would have been an increase of more than one hundred per cent instead of the decrease of 27 per cent. The influx of shoemakers during that decade was obviously disproportionate to the needs of that particular industry, but probably was not in excess of the needs of all industries.

NOTES

A USE FOR TRIGONOMETRIC TABLES IN CORRELATION

By Holbrook Working, *University of Minnesota*

In any problem in partial, or multiple, correlation, it is necessary to find the value of $\sqrt{1-r^2}$ or Log $\sqrt{1-r^2}$ for several different values of r. The same quantity also appears in the formula for the standard error of an equation of regression, $s_y=\sigma_y\sqrt{1-r^2}$.*

Where r varies between the limits $+1$ and -1, as is always the case in these formulae, there is an interesting and useful trigonometric relation between r and $\sqrt{1-r^2}$. Any one familiar with analytical geometry will recognize the equation $y=\sqrt{1-r^2}$ as the equation of a circle. There is also a simple geometrical proof of the relation. Draw the arc YAX with radius $OA=1$. Construct AX_1 perpendicular to OX_1, giving the right triangle OAX_1. By the familiar relation that the square of the hypotenuse equals the sum of the squares of the other two sides, we have $(AX_1)^2=(OA)^2-(OX_1)^2$. But OA being taken equal to unity and $OX_1=r$, we have $AX_1=\sqrt{1-r^2}$.

Now it is immediately apparent that AX_1 is the sine of angle α and that OX_1 is the cosine of angle α. It follows that if we find the angle whose cosine is r, we need but take the sine of that angle to get $\sqrt{1-r^2}$, or the Log of the sine to get Log $\sqrt{1-r^2}$. The reverse is also true. Briefly:

If $r=\cos\alpha$, $\sin\alpha=\sqrt{1-r^2}$, Log $\sin\alpha=$ Log $\sqrt{1-r^2}$.
If $r=\sin\alpha$, $\cos\alpha=\sqrt{1-r^2}$, Log $\cos\alpha=$ Log $\sqrt{1-r^2}$.

Knowing these relations, the value of $\sqrt{1-r^2}$ or of Log $\sqrt{1-r^2}$ may quickly be found in any table of the trigonometric functions. The accuracy with which these values may be found is very fair. Without interpolation a table giving the trigonometric function for each minute of arc gives an accuracy sufficient for the purpose of ordinary statistical investigation. For example, take $r=0.20$. The angle (of even minutes) whose sine is nearest 0.20 is the angle 11° 32′. Since fractions of minutes are neglected, the error in the angle taken may be $\frac{1}{2}$ minute, but not more than $\frac{1}{2}$ minute. The cosine of angle 11° 32′ is 0.97981. A difference of $\frac{1}{2}$ minute in the angle will change the cosine by 0.00003.

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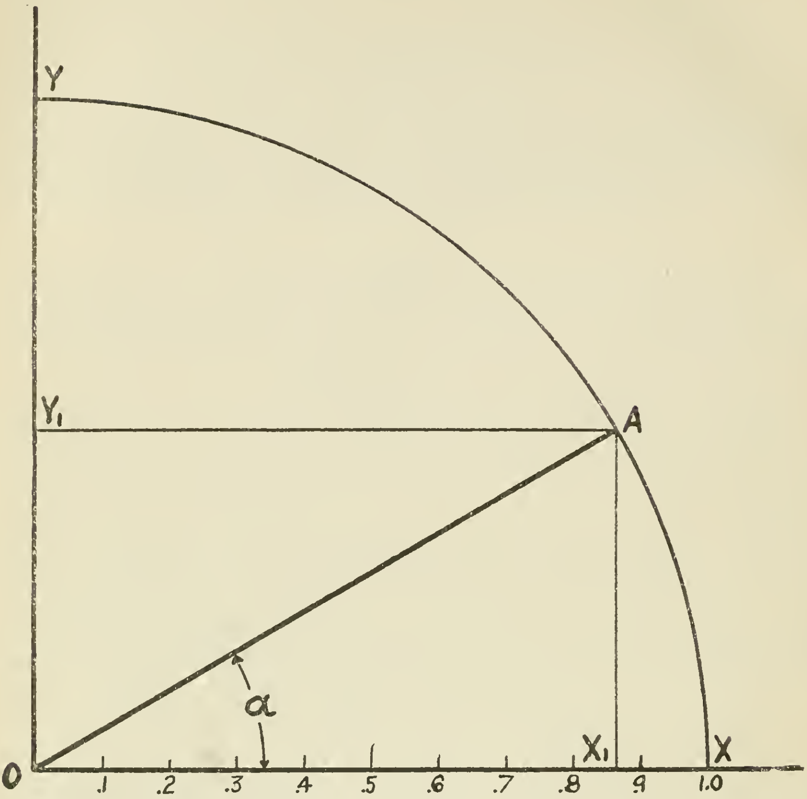
* The notation is that of Yule. Cf. Yule, *Introduction to the Theory of Statistics*, 5th Edition, p. 177.



This is the maximum possible error in the determination of $\sqrt{1-r^2}$ when $r=0.20$. For higher values of r the error is greater. If $r=0.99$ the maximum possible error in the determination of $\sqrt{1-r^2}$ is 0.00071. For $r=0.99$, again, the maximum possible error in the determination of Log $\sqrt{1-r^2}$ is 0.00044.

Therefore we may conclude that when a table giving the trigonometric functions for each minute of arc is used without interpolation, the value obtained for $\sqrt{1-r^2}$ or for Log $\sqrt{1-r^2}$ is accurate to at least three decimals. By interpolation, accuracy to at least four decimals may be obtained.

The accompanying table was prepared by the method outlined above, but using tables giving the functions to eight decimals for each sexagesimal second of arc.* In the table values of Log $\sqrt{1-r^2}$

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* The tables used were E. Gifford, *Natural Sines*, Manchester, 1914, and Bauschinger and Peters, *Logarithmic-Trigonometrical Tables*, Leipzig, 1911.

for the higher values of r may be in error as much as 0.000,004, but not more. The accuracy of the values given for $\sqrt{1-r^2}$ is slightly better.

VALUES OF $\sqrt{1-r^2}$ AND Log $\sqrt{1-r^2}$ TO SIX DECIMAL PLACES FOR VALUES OF r FROM .00 TO .99 FOR EACH CHANGE OF .01 IN r.*

r (sin α(	$\sqrt{1-r^2}$ (cos α)	Log $\sqrt{1-r^2}$ (Log cos α)	r (sin α)	$\sqrt{1-r^2}$ (cos α)	Log $\sqrt{1-r^2}$ (Log cos α)
.00	1.000 000	0.000 000	.50	.866 025	9.937 531
.01	.999 950	9.999 978	.51	.860 174	9.934 586
.02	.999 800	913	.52	.854 167	1 543
.03	.999 550	804	.53	.847 997	9.928 394
.04	.999 200	652	.54	.841 665	5 139
.05	.998 749	456	.55	.835 165	1 772
.06	.998 198	217	.56	.828 492	9.918 288
.07	.997 547	9.998 933	.57	.821 644	4 684
.08	.996 795	606	.58	.814 616	0 953
.09	.995 942	234	.59	.807 404	9.907 091
.10	.994 983	9.997 818	.60	.799 999	3 089
.11	.993 932	357	.61	.792 402	9.898 946
.12	.992 774	6 850	.62	.784 602	4 649
.13	.991 551	299	.63	.776 596	0 195
.14	.990 152	5 702	.64	.768 374	9.885 572
.15	.988 686	058	.65	.759 933	0 776
.16	.987 117	4 369	.66	.751 264	9.875 793
.17	.985 444	3 632	.67	.742 363	0 616
.18	.983 667	2 848	.68	.733 212	9.865 230
.19	.981 784	2 016	.69	.723 807	9.859 623
.20	.979 796	1 136	.70	.714 144	9.853 786
.21	.977 702	0 206	.71	.704 201	9.847 696
.22	.975 499	9.989 227	.72	.693 975	9.841 344
.23	.973 190	8 198	.73	.683 447	9.834 705
.24	.970 772	7 117	.74	.672 507	9.827 762
.25	.968 246	6 986	.75	.661 439	9.820 490
.26	.965 609	4 801	.76	.649 923	9.812 862
.27	.962 861	3 564	.77	.638 044	9.804 851
.28	.960 000	2 271	.78	.625 780	9.796 422
.29	.957 026	0 924	.79	.613 106	9.787 536
.30	.953 940	9.979 521	.80	.600 001	9.778 152
.31	.950 737	8 060	.81	.586 431	9.768 217
.32	.947 417	6 541	.82	.572 365	9.757 673
.33	.943 980	4 963	.83	.557 765	9.746 451
.34	.940 425	3 324	.84	.542 584	9.734 467
.35	.936 750	1 624	.85	.526 783	9.721 632
.36	.932 952	9.969 859	.86	.510 293	9.707 819
.37	.929 032	8 031	.87	.493 052	9.693 893
.38	.924 987	6 136	.88	.474 972	9.676 668
.39	.920 815	4 172	.89	.455 959	9.659 926
.40	.916 516	2 140	.90	.435 890	9.639 377
.41	.912 086	0 036	.91	.414 609	9.617 639
.42	.907 523	9.957 858	.92	.391 918	9.593 195
.43	.902 829	5 606	.93	.367 561	9.565 329
.44	.897 998	3 275	.94	.341 173	9.533 974
.45	.893 029	0 866	.95	.312 252	9.494 505
.46	.887 918	9.948 373	.96	.280 001	9.447 160
.47	.882 667	5 797	.97	.243 107	9.386 798
.48	.877 270	3 133	.98	.198 993	9.299 847
.49	.871 723	0 378	.99	.141 068	9.149 429

A study of the accompanying table results in some interesting conclusions regarding the accuracy with which r ought to be obtained in calculating the original correlation. The following relations are found: For values of r up to

0.10 0.45 0.71 0.89 0.95 0.97

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* Professor Bruce D. Mudgett has called my attention to a similar table, carried to a smaller number of decimals, appearing in a Bulletin of the University of Texas: *Tables to Facilitate the Calculation of Partial Coefficients of Correlation and Regression Equations*, by Truman Lee Kelley.

a change of 0.01 in r changes $\sqrt{1-r^2}$ less than:

0.001 0.005 0.01 0.02 0.03 0.04.

From the above it appears that when r does not exceed 0.71, $\sqrt{1-r^2}$ may be found to at least the same degree of accuracy as r.* For values of r over 0.71, $\sqrt{1-r^2}$ is not accurate to as many decimals as r, but is at least accurate to one decimal less than r.

It follows that in order to have $\sqrt{1-r^2}$ accurate to two decimals, values of r above 0.71 should be calculated to three decimals.

In order to have $\sqrt{1-r^2}$ accurate to *three* decimals, the value of r must be calculated as follows:

r not over 0.10	2 decimals suffice
r not over 0.71	3 decimals suffice
r over 0.71	4 decimals suffice

Taken in itself, the circumstance that in order to get $\sqrt{1-r^2}$ accurate to three decimals, r must be calculated to at least four decimals if it be larger than 0.71, does not prove that r should be calculated to four decimals. It has generally been considered that r should not be calculated beyond two or, at the most, three decimals, further accuracy being fictitious. If this assumption be well founded, it follows that the value of $\sqrt{1-r^2}$ may not be accurately found beyond one or, at the most, two decimals, if r be over 0.71. Which is the correct conclusion: that where r is over 0.71, its value should be calculated to a larger number of places than for lower values; or that where r is over 0.71, $\sqrt{1-r^2}$ cannot be found accurately to as many places as for lower values of r?

The problem may be approached by a consideration of the properties of the standard error ($\sigma_y \sqrt{1-r^2}$), which measures the dispersion of the observations about the line of regression. Given the equation of regression, the standard error may be calculated quite independently of the coefficient of correlation by finding the deviation of each observation from the line of regression and calculating the root-mean-square of these deviations. The writer sees no reason for considering that the standard error can be determined with any greater accuracy where the correlation is low than where the correlation is high. But if the standard error, which is $\sigma_y \sqrt{1-r^2}$, may be determined with as great accuracy for high values of r as for low values, it follows, since σ_y is not affected by the closeness of the correlation, that $\sqrt{1-r^2}$ may be determined with as great accuracy for high values of r as for low values. If this be true, it follows further that for high values of r its value should be calculated to a larger number of decimals than for low values.

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* The accuracy referred to is, of course, not a question of the method used, but is inherent in the relation of r to $\sqrt{1-r^2}$.

Since, as noted above, a table giving the sines and cosines for each minute of arc gives $\sqrt{1-r^2}$ accurate to at least three decimal places without interpolation, such a table used without interpolation is adequate where r is calculated to the number of decimals indicated in the preceding table, that is, where r is calculated so as to give $\sqrt{1-r^2}$ accurate to three decimals.* Seldom, if ever, is it desirable to calculate the value of r to a larger number of decimals; the apparent greater accuracy would be fictitious.

THE GRAPHIC REPRESENTATION OF A FREQUENCY DISTRIBUTION

By Robert E. Chaddock, *Columbia University*

In the accompanying diagrams and the explanatory text the purpose is two-fold: (1) to present a method of exposition by which the student of elementary statistical methods will be enabled to comprehend more clearly the nature of the frequency distribution and the assumptions underlying grouped data; (2) to correct or clarify the rules for locating the median and quartiles which appear in some of the widely used elementary text-books. The student is told to add one to the number of cases and to divide by two $\frac{(n+1)}{2}$ in order to locate the mid-item in the array, the value of which is the median average. But if this rule is followed, slightly different values are secured for the median, depending on whether the calculation is made from the lower toward the higher values in the array, or from the higher toward the lower, whereas either procedure should yield exactly the same result. The reason is clear. One extra item has been inserted. After all, what we seek is not a case but a value in an array of items arranged in a regularly ascending or descending order of values, which are assumed to be evenly distributed over the scale within a given class interval so that progress in one direction shows constantly increasing values, and in the other direction constantly decreasing values.

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* For this purpose the most convenient tables the writer has seen are in G. W. Jones: *Logarithmic Tables*. London: Macmillan, 1898. These tables give the natural and logarithmic functions in parallel columns for each minute of arc.

DIAGRAM I.

DISTRIBUTION OF PIECE-RATE EARNINGS IN 50 CENT GROUPS

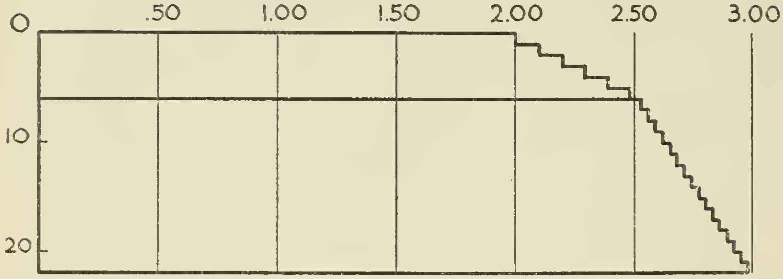

Fig. 1 SHOWING INDIVIDUAL VARIATIONS

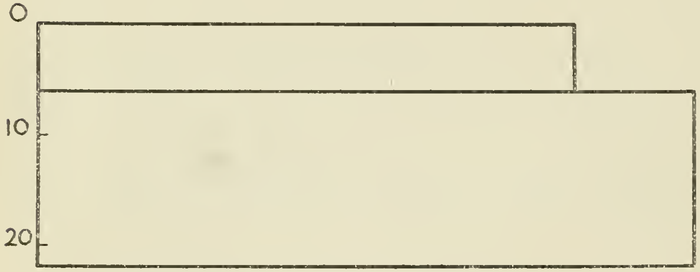

Fig. 2 SHOWING GROUP VARIATIONS

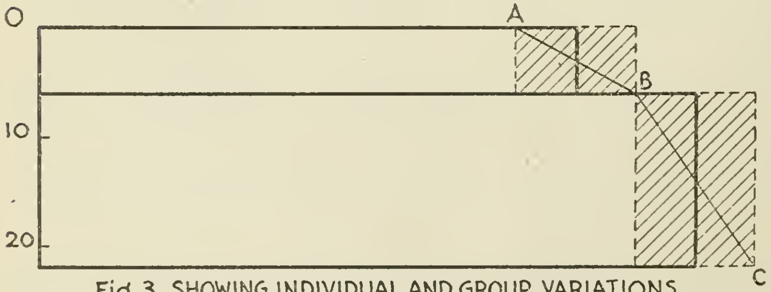

Fig. 3 SHOWING INDIVIDUAL AND GROUP VARIATIONS

The data in the illustration, presented in the form of a frequency table in Diagram II, are distributed with a fair degree of regularity because piece-rate earnings are used in 50 cent groups.* The amount of the wage is shown on the horizontal scale, and the number of wage earners on the vertical scale. Figure 1 in Diagram I shows the first two groups at the lower values on the scale distributed by individual wage earners as well as by groups, *on the assumption of even distribution* of 6 cases in the first group and 16 cases in the second group. A rectangular step on the horizontal scale and a space on the vertical scale are shown for each wage item. The distance between the limiting lines on the vertical scale shows the number of items in each group, 6 and 16 respectively.

Figure 2 shows the same facts, but the 6 items in the lower group are now given the same value on the horizontal scale concentrated at the middle of the 50 cent range, at $2.25, as would be given in fact in calculating the arithmetic average of the entire array shown in Diagram II. Likewise, the 16 items of the second group are concentrated at $2.75.

Figure 3 combines the facts of both figures 1 and 2. The cross-hatched areas show two things: (a) the range along the horizontal scale over which the items of the group are actually distributed from the smallest value to the largest, and (b) the number of items in each group, measured on the vertical scale. The diagonal *A-B* shows the increasing values in that group of 6 items, from the lowest values at *A* to the greatest at *B*, which was indicated by the steps in figure 1. The diagonal *B-C* shows the same for the 16 items of the second group, the steps in each case having been smoothed by the straight lines *A-B-C*.

Here it may be objected that values are not usually distributed over the range of class intervals so regularly as indicated in figures 1 and 3. This situation is admitted. They may be more closely grouped at the lower or upper limits of the given interval or over the upper half of the interval as compared with the lower half. But this very objection merely emphasizes the importance of the choice of the width of the interval for classifying the items, and the importance of locating experimentally the lower and upper limits of the interval. If natural massing points of the items can be discovered, these should constitute the mid-values of the class interval, shown in figure 2, as far as possible, at which all the values of the group are concentrated for practical purposes in calculating the arithmetic average. Thus, less error will be introduced in calculating the arithmetic average from grouped data as compared with the true average calculated from the individual items without grouping. In most data some classification and grouping of items is essential for ease and clearness in handling.

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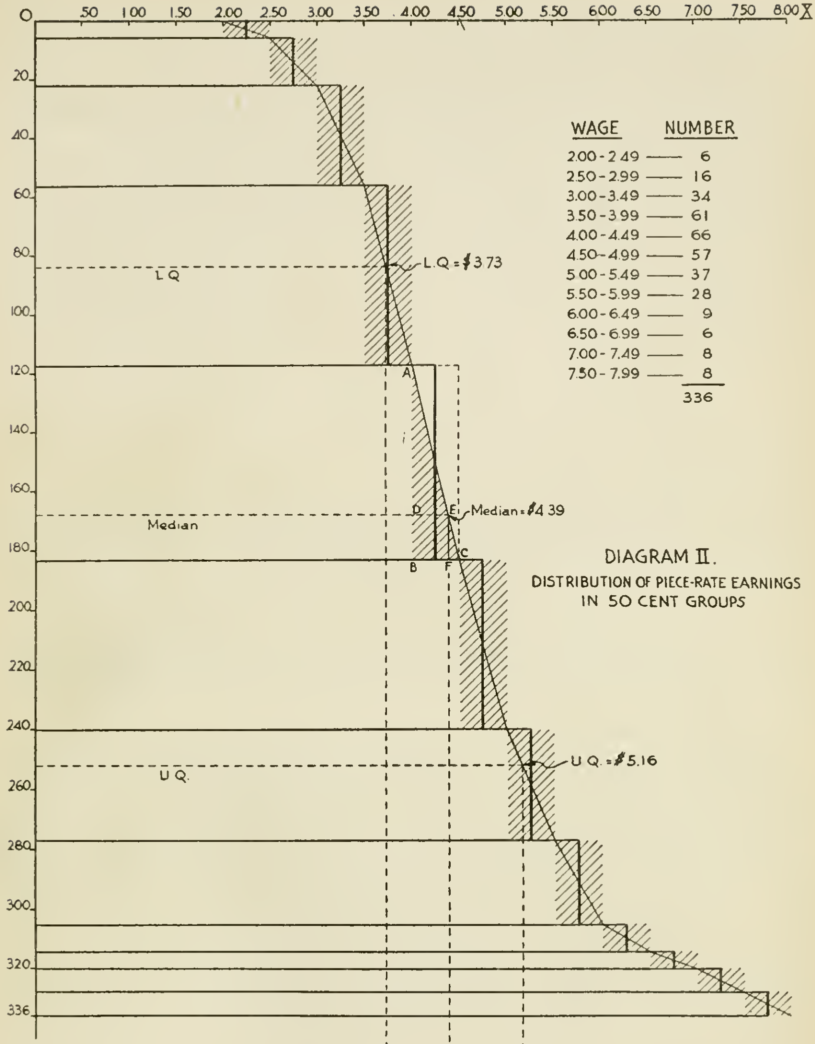
* The unit in which wages are paid is not capable of indefinite subdivision as in the case of measurement of height, weight, or time. This fact may affect the distribution over the class interval and the massing of cases at certain values on the scale. This is especially true in time wages, but we are using piece-rate earnings where the smallest subdivision of the unit of payment is one cent. Therefore, within any class interval of 50 cents there are many subdivisions possible, and the assumption for such data as height and weight may be made and the same methods of treatment may be employed.

In Diagram II the procedure of figure 3 in Diagram I has been carried out for each group in the entire array of 336 wage items. The limiting lines on the vertical scale show the number of cases in each group, as does also the height of the cross-hatched areas. The total height of cross-hatched areas indicates the total of the items, 336. In each group the width of the cross-hatched area is the same, measuring on the horizontal scale the range of variation for that group, the 50 cent interval. Now, if we project or let fall all the cross-hatched areas upon a common base line *O-X*, shown in Diagram III, in the exact relation and size on the horizontal and vertical scales in which they are found in Diagram II, the result will be a *surface of frequency*, sometimes called a *histogram* or *column diagram*. The height of each rectangular area above the base line represents the proper number of cases in that group, and the total area represents the total items. The total cross-hatched area in Diagram II is identical with the total area of Diagram III. By the dotted line connecting the mid-points of the tops of the columns, in Diagram III, the histogram may be readily converted into the *frequency polygon*, and by appropriate methods this may be further smoothed into a *frequency curve*, showing the distribution of values around a central tendency. This procedure is fundamental in statistical analysis.

THE EXACT LOCATION OF THE MEDIAN VALUE IN GROUPED DATA

Using Diagram II and noting that the number of items is even (336), we must locate a value on the horizontal scale, such that there will be as many value items above as below. Half the items would be $\frac{336}{2}=$ 168 items. If we count down on the vertical scale through the first four groups there will be 117 items. This brings us to the wage item of \$4.00 on the horizontal scale. If we count in addition all of the fifth group, which has 66 items in it, there will be 183 items in the first five groups, up to \$4.50 on the horizontal scale. But we wish a value that will show only 168 items below and the same above. Therefore, the median value must lie somewhere in the fifth group between \$4.00 and less than \$4.50. This group of 66 items is distributed evenly, by assumption, over the 50 cent interval. The lowest value in this group is at \$4.00 and the highest just under \$4.50, as shown by the diagonal *A-C* and the distance *B-C* in Diagram II. How many of the 66 items do we need,



WAGE	NUMBER
2.00 - 2.49	6
2.50 - 2.99	16
3.00 - 3.49	34
3.50 - 3.99	61
4.00 - 4.49	66
4.50 - 4.99	57
5.00 - 5.49	37
5.50 - 5.99	28
6.00 - 6.49	9
6.50 - 6.99	6
7.00 - 7.49	8
7.50 - 7.99	8
	336

DIAGRAM II.
DISTRIBUTION OF PIECE-RATE EARNINGS IN 50 CENT GROUPS

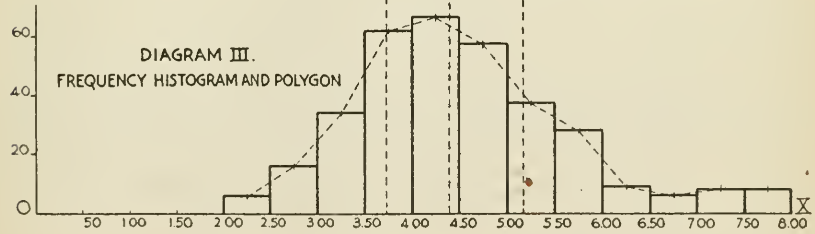


DIAGRAM III.
FREQUENCY HISTOGRAM AND POLYGON

added to the 117 of the first four groups, to complete the 168 items which must lie below the median value of the entire array? There are needed $168-117=51$ items to complete the 168 within the fifth group, as shown by the distance *A-D* measured on the vertical scale. Now these items in this group are increasing in size as we count from *A* toward *D*, as shown along the diagonal *A-C*. Beginning with $4.00 at *A*, the lower limit of the group, how much greater will the value be when we have counted 51 items along the vertical scale toward *B*? *A-B* represents 66 items, *B-C* represents 50 cents, and *A-D* represents 51 items. What will be the value range represented by *D-E*? The triangles *ABC* and *ADE* are similar. Therefore, the proportion $AB:BC::AD:DE$ will be true. The value to be found is *DE*. Substituting known values, we have 66:50 cents::51:DE, or $66DE=2550$, and $DE=39$ cents. Adding 39 cents to $4.00, the lower limit of the group, we have $4.39, the median value.

Or, reasoning in terms of proportions, on the assumption of even distribution, it follows that if 66 items are distributed over the entire range of 50 cents (*B-C*), in the fifth group, 51 items which must be added in order to have 168 items below the median value, will range over $\frac{51}{66}$ of 50 cents, or 39 cents (*D-E*), which amount must be added to the lowest wage item of the group, $4.00, in order to arrive at the median value at *E*.

Exactly the same value for the median will be secured if we begin at the bottom of Diagram II, the highest wage values, and count upward on the vertical scale of the diagram. As we proceed the wage items grow progressively smaller in each group. At the upper limit of the group of 66 items (*C*), where the value is $4.50, we have counted 153 items. It requires 15 more items in the group of 66 to fulfil the condition that 168 wage items must be greater than the median value. In the previous calculation we counted into this same group 51 items from the lower limit in order to arrive at the median. Now, we count 15 items from the upper limit to arrive at exactly the same point. $AD=51$, *DB* or $EF=15$, and $AD+EF=66$, the entire group. The wage values are now decreasing along the diagonal *C* to *E* where the median lies. The value to be subtracted from $4.50 may be secured as before by a proportion $AB:BC::EF:FC$, or 66:50 cents::15:*FC*, which gives 11 cents for the value of *FC*; $4.50 − .11 = $4.39; the median value, or if 66 items range over 50 cents (*B-C*), 15 items will range over $\frac{15}{66}$ of 50 cents, or 11 cents (*F-C*).

The quartiles may be secured by dividing the items by 4 and proceeding in exactly the same manner to locate the value in the array which has $\frac{1}{4}$ of the items below and $\frac{3}{4}$ of the items above it, and also the value in the array which has $\frac{3}{4}$ of the items below and $\frac{1}{4}$ above it.

Let a perpendicular fall from E in Diagram II upon the base line O-X and it will divide the area of Diagram III into two equal parts, according to the definition of the median. Like perpendicular lines, let fall from the quartile positions of Diagram II, will divide Diagram III into four equal areas.

The deciles and percentiles may be located in a similar manner.

OBSERVATIONS ON THE $\frac{n+1}{2}$ PROCEDURE FOR LOCATING THE MEDIAN

This rule is an expedient for locating the mid-case if the numbers in the array are odd, and a position between the two mid-cases if the number of cases is even. It is not a case we seek but a value. Changing values through the array are associated with movement in one direction or the other on the assumption of an even distribution over the class interval. If one case is added it will not be possible to secure the same value for the median when calculated from both the lower and upper limits of the array because the extra case introduces a slight duplication.

It is not necessary to introduce this contradiction in the procedure. In Diagram I, figure 1, a rectangular area was shown for each item, as well as for the group. A space on the vertical scale represented each item. If the number of spaces on the vertical scale, corresponding to the number of items, is even, as in our illustration in Diagram II, we count through $\frac{1}{2}$ of the spaces on the vertical scale, which brings us to a point on the line separating the two spaces representing the two mid-items. On the horizontal scale this represents a value interpolated, or the average value of the two mid-items. If the number of items is odd, in like manner we locate the mid-point on the vertical scale and find it in the middle of the space representing the mid-item of the array, with an equal number of spaces above and below it. On the horizontal scale this represents the value of the mid-item, with an equal number of items above and below it. This may be shown by supposing that the illustration in Diagram II has 337 items. Therefore, when calculating the median, quartiles, etc., for grouped data, we should use the actual number of items instead of adding one.

SHORT TERM BORROWING IN BRITISH FINANCE, 1914–1920

The accompanying charts showing the quarterly receipts of the British Treasury during the past six and a half years make it possible to compare in the case of British public finance the relative importance of different methods of raising funds during this period. The statistics upon which the charts are based have been collected by the Division of Analysis and Research of the Federal Reserve Board in connection with studies which are being made of foreign banking and finance.

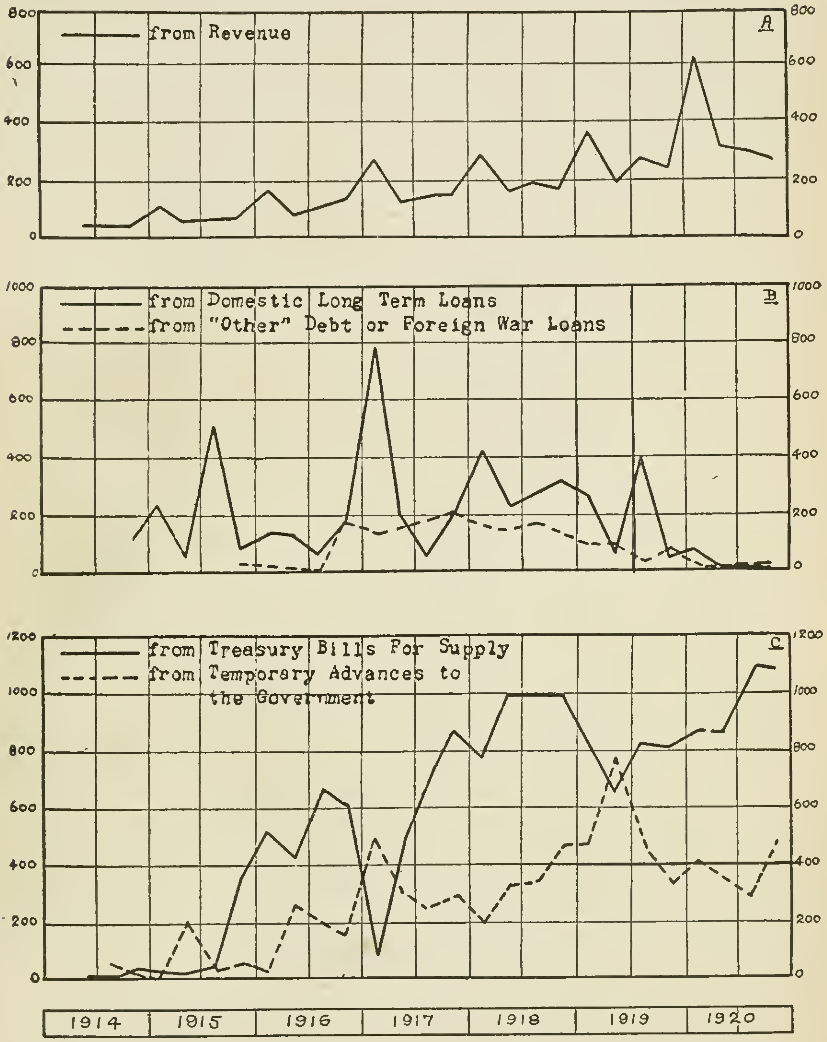
The charts clearly indicate the outstanding importance of the short term Treasury bill as a source of public funds. As in the case of the United States Treasury, the British Treasury depends upon the sale of short term bills to provide cash in anticipation of receipts from taxes and longer term loans. Before the war the same method was used, but on a scale in no sense comparable with that of the war period. Treasury bills outstanding before the war did not exceed £20,000,000, whereas in recent years they have frequently exceeded the billion pound mark.

In the United States the Treasury depends entirely upon the sale of certificates of indebtedness to supply it with temporary funds. In England, on the other hand, as in France, a supplementary method is used in case Treasury bill sales are insufficient to provide the necessary cash. In France the Treasury under these circumstances obtains advances from the Bank of France. In England the Treasury applies to the Bank of England or to other public departments. The sale of Treasury bills, however, is the preferred method, since they furnish a form of investment which may be taken up by real savings, while advances from the Bank of England consist of credits created on the books of the Bank and obviously make directly for inflation. Advances from "other public departments," it is understood, are mainly drawn from the currency notes fund.

Charts B and C show that during the first year of the war, two large war loans were placed in England, providing sufficient funds in addition to those from revenue to make unnecessary the sale of Treasury bills on a large scale. During the following period, on the other hand—covering late 1915 and 1916—no long term loans were placed, and the Treasury depended very largely upon the returns from the sale of Treasury bills to provide current funds. In January 1917, the third big war loan was placed, providing for the funding of £131,000,000 of Treasury bills then outstanding; but immediately following the floating of the loan it was necessary again to turn to Treasury bills as a source of current funds. Between this time and the end of 1918, more and more Treasury bills were issued; Treasury receipts from this source amounted to £5,762,000,000, while receipts from long term loans amounted to £1,216,000,000, and from taxes £1,684,000,000. In 1919 only a small number of Treasury bills were funded in the loan floated in June, and since that time no long term loans have been placed.

The importance of the temporary advances by the Bank of England and other public departments is clearly shown in Chart C. Ever since early in 1916 it has been necessary for the Treasury to obtain such advances when receipts from Treasury bills were insufficient or when large numbers of them matured. In the first quarter of 1917 and again in 1919, these advances on ways and means actually exceeded receipts from Treasury bills. In both cases this occurred during a period when the sale of Treasury bills had been suspended (at the time of the floating of a long term loan) and when a considerable number of bills were being funded.

Although the total debt of England was somewhat reduced during 1920 (owing to repayment of certain foreign loans), the floating debt was increased by £59,000,000. The entire increase occurred in ways and means advances. How to handle this large floating debt—which amounted to £1,408,000,000 at the end of 1920—is a problem



QUARTERLY RECEIPTS BY THE BRITISH TREASURY, 1914-1920

In millions of pounds sterling

which is considerably under discussion in England. It may be possible to fund in part the Treasury bills outstanding. To pay them off even gradually will involve a heavy rate of taxation for years to come. The elimination of borrowing on ways and means is of even more pressing importance, however, since these advances result in an increase in the balances of the joint stock banks at the Bank of England.

Katharine Snodgrass

SUMMARY AND GROUP CORRELATION

The possibility of finding the arithmetic mean of several groups separately, and combining the data in order to find the arithmetic mean of the combined groups, is well known and is frequently used to save the labor of additional computations. It may not be generally known that an analagous process is available in the case of the coefficient of correlation.

Let x and y be the deviations, and A and B the averages of two series, the original values being expressed by X and Y.

Then
$$\begin{aligned}\Sigma xy &= \Sigma(X-A)(Y-B)\\ &= \Sigma XY + nAB - A\Sigma Y - B\Sigma X\\ &= \Sigma XY + \frac{n(\Sigma X)(\Sigma Y)}{n\quad n} - \frac{(\Sigma X)(\Sigma Y)}{n} - \frac{(\Sigma X)(\Sigma Y)}{n}\\ &= \Sigma XY - \frac{(\Sigma X)(\Sigma Y)}{n}\end{aligned}$$

$$\begin{aligned}\Sigma x^2 &= \Sigma(X-A)^2\\ &= \Sigma X^2 - 2A\Sigma X + nA^2\\ &= \Sigma X^2 - 2\frac{(\Sigma X)(\Sigma X)}{n} + n\frac{(\Sigma X)^2}{n^2}\\ &= \Sigma X^2 - \frac{(\Sigma X)^2}{n}\end{aligned}$$

and, similarly, $\Sigma y^2 = \Sigma Y^2 - \dfrac{(\Sigma Y^2)}{n}$.

Hence
$$\begin{aligned} r &= \frac{\Sigma xy}{n^{\sigma}x^{\sigma}y} = \frac{\Sigma xy}{\sqrt{\Sigma x^2 \Sigma y^2}}\\ &= \frac{\Sigma XY - \dfrac{(\Sigma X)(\Sigma Y)}{n}}{\sqrt{\left[\Sigma X^2 - \dfrac{(\Sigma X)^2}{n}\right]\left[\Sigma Y^2 - \dfrac{(\Sigma Y)^2}{n}\right]}}\\ &= \frac{n\Sigma XY - (\Sigma X)(\Sigma Y)}{\sqrt{[n\Sigma X^2 - (\Sigma X)^2][n\Sigma Y^2 - (\Sigma Y)^2]}}.\end{aligned}$$

Since X and Y may be any scalar values, the items may be grouped into classes, and arbitrary values may be assigned to the classes, *e. g.*, −2, −1, 0, +1, +2. . . .

If in two or more groups the same arbitrary class values are used, the number of items in one group being n_1, in another n_2, etc., the correlation coefficient for each group may be obtained separately, and by a simple computation the correlation coefficient for the combined groups may be obtained:

$$r = \frac{(n_1+n_2+\ .\ .\ .)\Sigma(\Sigma XY) - [(\Sigma X)(\Sigma Y)]}{\sqrt{\left\{(n_1+n_2+\ .\ .\ .)\Sigma(\Sigma X^2) - \Sigma[(\Sigma X)^2]\right\}\left\{(n_1+n_2+\ .\ .\ .)\Sigma(\Sigma Y_2) - \Sigma[(\Sigma Y)^2]\right\}}}.$$

HERBERT A. STURGES

University of Washington

PROGRESS OF THE CENSUS OF AGRICULTURE

Of the various schedules used for collecting the information covered by a decennial census, the farm or agricultural schedule is the most elaborate. It provides spaces for more than four hundred different items, although of course only a small proportion of these items needs to be filled out for any one farm. The Director of the Thirteenth Census (1910) expressed the opinion that the number of inquiries on the schedule used at that census should be reduced by one-half or two-thirds. But probably no such reduction as that could have been made without lessening materially the value of this important branch of the census inquiry. The number of items, however, was reduced somewhat at the present census, there having been more than five hundred in 1910.

The schedule contains 8 questions regarding the farmer or farm operator; 7 regarding the form of tenure; 10 as to acreage, the acreage being classified with respect to the kind of land and the purpose for which it is used; 3 as to the value of the farm; 3 as to encumbrances on the farm; 4 as to expenditures for feed, labor, and fertilizer; 4 as to irrigation; and 5 as to drainage. Then follows an inventory of farm animals classified not only by kind but with respect to age also, so as to distinguish the growing colts and calves from mature horses and cattle. By far the greater part of the schedule, however, is taken up with the subject of farm products; and it is the variety and the number of these products which make the schedule so elaborate. It distinguishes 13 different hay and forage crops; 19 grain and feed crops; 11 varieties of vegetables; 16 fruit crops; 6 other field crops, including such important crops as cotton and tobacco; and outside of all these, the potato, sugar, and nut crops. Then there are the various dairy and meat products of the farm to be accounted for—the poultry, eggs, milk and butter and cheese, the pigs and calves slaughtered, etc.

As a rule three items are asked for under each crop, viz., the acreage harvested, the quantity harvested, and the quantity sold and to be sold. In former censuses the value of the crop was also called for; at this census that item of information has been omitted, but the values of the crops will be estimated on the basis of average prices obtained through the Department of Agriculture. Taking the place of the question as to value is that as to the quantity of the crop sold or to be sold, which in its general application is a new feature of the agricultural schedule introduced at this census. Another new subject of inquiry is that of farm facilities, questions being included regarding the number of tractors, automobiles and motor trucks, and whether the farm has a telephone, water piped into the house, and gas or electric light.

The number of farm schedules filled out at this census was approximately 6,500,000, the exact number of farms tabulated being 6,485,160.

For the first time in the history of the census the farm schedules have been tabulated by the use of the punch card and electrical tabulating machines. It is very evident, however, that no single punch card will provide for all the items on this elaborate schedule. It was found necessary, in fact, to use 17 different cards, each covering a different portion of the schedule. In the aggregate 142,696,217 cards were punched.

The card punching and tabulation have been completed and the publication of the results in the form of state bulletins has been begun. Bulletins have already appeared for 20 states and for Hawaii, Alaska, and the District of Columbia, and it is expected that the series will be completed by the first of September. The state bulletin contains 5 county tables covering the following subjects:

1. Farms and farm property
2. Live stock on farms and ranges
3. Domestic animals not on farms or ranges
4. Value of all crops, and acreage and production of principal crops
5. Mortgage debt and expenditures for labor, fertilizer and feed

Altogether this series of tables will present over 300 items of information for every county in the United States. On the subjects which these tables cover the Bureau does not contemplate publishing any further details for either states or counties, and, therefore, so far as these subjects are concerned—and they comprise the main part of the agricultural schedule—the census figures will all be "out" as soon as this series of bulletins is completed. But in the final volumes of the census reports the statistics will be reassembled and presented by subjects primarily instead of by states.

There are, however, a number of subjects which are not covered by these state bulletins and on which special bulletins or monographs will probably be issued later. These include pure bred live stock, farm facilities, coöperative marketing, forests and forest products, young animals raised on farms, domestic animals slaughtered on farms, nurseries, and green-houses.

Mention should be made also of the subjects of irrigation and drainage, which are closely related to agriculture though not strictly a part of the census of agriculture and not covered by the agricultural schedule. Previous censuses have covered the subject of irrigation, but this is the first time that the subject of drainage has been included. Two state bulletins have been issued on irrigation, and five on drainage.

J. A. Hill

STATURE AND WEIGHT OF CHILDREN

The Children's Bureau has recently issued basic tables of heights and weights for white children under six years of age, in advance of publication of a final bulletin. These tables show average heights and weights by age and sex from birth to 72 months, and average weights for children of different heights. They are based upon measurements of 167,024 white children. The records included in the tabulation were carefully selected from over 2,000,000 records received by the Bureau during the Children's Year Campaign. The basis of selection was fourfold: (1) the record card must have been signed by a physician; (2) no serious defects should have been noted; (3) the child must have been weighed and measured without clothing, as verified by the physician signing the card; (4) all essential items must have been answered. The children included in the tabulation were 76 per cent of native mothers, four per cent of British and Irish parentage, and the remainder of Scandinavian, Italian, and other racial stocks. They represent children from every part of the country. The averages for white children of native parentage agree very closely with these averages for all white children.

The full report, it is announced, will contain comparisons of rural and city children, of children of native parentage, children of Italian, German, and Scandinavian parentage, and a study of the correlation between the presence of certain abnormal conditions and stature and weight.

TABLE I

STATURE AND WEIGHT OF WHITE CHILDREN FROM BIRTH TO 6 YEARS OF AGE, SMOOTHED FIGURES

Age	Boys		Girls	
	Stature (inches)	Weight* (pounds)	Stature (inches)	Weight* (pounds)
Under 1 month	21.16	9.11	20.89	8.65
1 month, under 2	22.47	10.88	21.92	10.14
2 months, under 3	23.58	12.61	23.09	11.71
3 months, under 4	24.55	14.07	24.00	13.03
4 months, under 5	25.38	15.37	24.83	14.25
5 months, under 6	26.10	16.50	25.53	15.32
6 months, under 7	26.72	17.47	26.15	16.26
7 months, under 8	27.27	18.31	26.70	17.09
8 months, under 9	27.76	19.04	27.20	17.81
9 months, under 10	28.21	19.68	27.66	18.45
10 months, under 11	28.64	20.27	28.10	19.03
11 months, under 12	29.06	20.81	28.51	19.56
12 months, under 13	29.47	21.32	28.91	20.04
13 months, under 14	29.87	21.82	29.30	20.51
14 months, under 15	30.26	22.31	29.69	20.96
15 months, under 16	30.64	22.78	30.08	21.42
16 months, under 17	31.02	23.25	30.47	21.88
17 months, under 18	31.39	23.72	30.86	22.35
18 months, under 19	31.76	24.18	31.24	22.81
19 months, under 20	32.11	24.62	31.60	23.26
20 months, under 21	32.44	25.04	31.93	23.68
21 months, under 22	32.76	25.45	32.24	24.07
22 months, under 23	33.06	25.84	32.53	24.45
23 months, under 24	33.34	26.21	32.81	24.81
24 months, under 25	33.62	26.58	33.09	25.17
25 months, under 26	33.89	26.95	33.37	25.54
26 months, under 27	34.16	27.31	33.66	25.92
27 months, under 28	34.43	27.68	33.95	26.31
28 months, under 29	34.71	28.06	34.24	26.70
29 months, under 30	34.99	28.45	34.53	27.09
30 months, under 31	35.27	28.83	34.82	27.48
31 months, under 32	35.54	29.20	35.09	27.85
32 months, under 33	35.79	29.56	35.34	28.20
33 months, under 34	36.02	29.88	35.58	28.54
34 months, under 35	36.24	30.18	35.81	28.88
35 months, under 36	36.46	30.47	36.03	29.20
36 months, under 37	36.67	30.75	36.25	29.51
37 months, under 38	36.89	31.04	36.48	29.82
38 months, under 39	37.11	31.34	36.72	30.13
39 months, under 40	37.34	31.67	36.96	30.46
40 months, under 41	37.57	32.01	37.21	30.79
41 months, under 42	37.81	32.36	37.46	31.12
42 months, under 43	38.05	32.71	37.70	31.44
43 months, under 44	38.29	33.05	37.92	31.73
44 months, under 45	38.51	33.36	38.13	32.00
45 months, under 46	38.72	33.65	38.33	32.27
46 months, under 47	38.91	33.91	38.52	32.53
47 months, under 48	39.09	34.14	38.70	32.78
48 months, under 49	39.25	34.36	38.89	33.05
49 months, under 50	39.42	34.59	39.08	33.31
50 months, under 51	39.59	34.82	39.27	33.57
51 months, under 52	39.77	35.06	39.47	33.84
52 months, under 53	39.96	35.33	39.69	34.17
53 months, under 54	40.18	35.63	39.91	34.48
54 months, under 55	40.40	35.94	40.14	34.81
55 months, under 56	40.62	36.27	40.36	35.14
56 months, under 57	40.83	36.61	40.58	35.45
57 months, under 58	41.03	36.94	40.79	35.75
58 months, under 59	41.22	37.28	40.98	36.05
59 months, under 60	41.40	37.60	41.16	36.35
60 months, under 61	41.57	37.91	41.34	36.65
61 months, under 62	41.75	38.20	41.52	36.94
62 months, under 63	41.93	38.48	41.69	37.23
63 months, under 64	42.11	38.75	41.86	37.52
64 months, under 65	42.31	39.05	42.03	37.80
65 months, under 66	42.51	39.36	42.20	38.09
66 months, under 67	42.71	39.69	42.38	38.42
67 months, under 68	42.91	40.03	42.58	38.74
68 months, under 69	43.10	40.39	42.81	39.14
69 months, under 70	43.32	40.72	43.03	39.53
70 months, under 71	43.48	41.17	43.39	40.17
71 months, under 72	43.87	41.40	43.52	40.36

* Weights do not include clothing.

TABLE II

AVERAGE WEIGHT FOR HEIGHT, BY SEX; WHITE CHILDREN *

Stature (inches)	Boys		Girls	
	Number	Average weight† (pounds)	Number	Average weight† (pounds)
20	206	8.19	310	8.13
21	486	9.47	654	9.28
22	905	10.55	1,121	10.53
23	1,352	11.94	1,635	11.88
24	1,994	13.47	2,318	13.33
25	2,496	15.01	2,866	14.82
26	3,068	16.60	3,179	16.35
27	3,525	18.03	3,561	17.66
28	3,775	19.39	3,471	19.01
29	3,605	20.68	3,425	20.20
30	3,671	21.99	3,563	21.30
31	3,834	23.24	3,750	22.60
32	3,803	24.56	3,805	23.81
33	4,075	25.80	3,951	25.06
34	4,533	27.12	4,405	26.41
35	4,698	28.41	4,596	27.75
36	5,159	29.72	4,919	29.13
37	5,074	31.09	4,974	30.37
38	5,265	32.44	4,973	31.71
39	5,133	33.84	4,823	32.99
40	4,769	35.28	4,505	34.49
41	4,181	36.83	3,894	36.02
42	3,393	38.38	3,002	37.49
43	2,312	40.13	2,020	39.23
44	1,598	41.73	1,341	40.94
45	857	43.50	703	42.79
46	423	45.41	349	45.00
47	193	47.29	143	46.85

* Averages are not shown for statures under 20 inches nor for statures 48 inches or over, since the numbers of children of these statures were too small to afford satisfactory averages.

† Weights do not include clothing.

R. M. WOODBURY

STATISTICAL ACTIVITIES IN CENTRAL EUROPE

The governments of Central Europe are not falling materially behind in their statistical publications. Regardless of the frightful economic consequences of the war, most of the countries, states, and cities have continued to issue periodical reports of the utmost practical value in the furtherance of plans of reorganization and rehabilitation. Particularly is this true of Austria, which, in spite of appalling economic disadvantages, has not neglected the first duty of the state to keep itself and the public properly informed regarding the essentials of community life as represented in the current statistics of collective phenomena. During 1918 there was published the *Yearbook of Austrian Cities*, by the Statistical Central Committee, containing a wealth of information in the most convenient form, which, if available for American cities, would unquestionably materially advance the cause of good government. During the same year, and regardless of the disorganization common to all Central European countries during the latter years of the war, there was issued the thirty-fifth volume of the *Austrian Statistical Yearbook*, by the Statistical Central Commission, for the period 1916–17, including the latest available information on all the essentials of the social and economic conditions of what formerly was the Austrian Empire. The publications of the Austrian census of 1910 were also issued regardless of the war, and it is practically a certainty that for many years to come these reports for the separate constituent parts of the late Austrian monarchy will constitute a most useful and trustworthy source of information.

But the most extraordinary contribution to statistical literature is the *Preliminary Report of the Census of the Austrian Republic*, as of January 31, 1920, communicated to the government by the president of the Statistical Central Commission under date of May, 1920, comprehending a brief analysis of all the essential facts of population, housing, war prisoners, etc., with comparative data for certain foreign countries. The rapid manipulation of the statistical material reflects credit upon the statistical authorities who are confronted by many difficulties of an extraordinary nature. The total population of what is now the Austrian Republic, which had increased from 5,650,000 in 1900 to 6,294,000 in 1910, had decreased by 1920 to 6,067,000, or, in round figures, 227,000, or 3.61 per cent. For the large cities the decrease in population during the decade ending with 1920 was 9.33 per cent for Vienna, and 9.68 per cent for Klagenfurt. Other cities show an increase, but of minor significance contrasted with the very material decrease in the case of the city of Vienna.

The male population of the Austrian Republic during the decade ending with 1920 decreased 6.61 per cent, while the female population decreased 0.68 per cent; but in the case of the city of Vienna alone the decrease in male population was 12.52 per cent, against 6.39 per cent for the female population.

The accentuated housing condition is illustrated by an increase of only 1.15 per cent in housing accommodation during the period ending with 1920, against an increase of 7.23 per cent during the decade ending with 1910.

The questionnaire required information regarding war prisoners and persons missing or unaccounted for as a result of the war. The number of Austrian war prisoners still absent from home and held in some foreign country was 19,378, or 3.19 per 1,000 of population. The number missing or unaccounted for prisoners as a result of the war was 22,351, or 3.68 per 1,000. These reports, however, are considered as falling below the truth.

Reference is made in the report to the Census of Bavaria as of October 8, 1919, indicating an actual decrease in the male population of 20,936. The census for Prussia as of October 8, 1919, indicated an actual increase in population of 727,000, while in Saxony there was an ascertained decrease during the preceding decade of 138,000, or 2.9 per cent. For the city of Berlin the census of October 8, 1919, returned a population of 1,902,000, against 2,071,000 as of December 1, 1910. During practically the same period, however, the population of Munich increased at the rate of 4.3 per cent. These figures would clearly indicate that Austria suffered more in population losses than Germany or any of its larger constituent parts.

In addition to the foregoing statistical publications the Austrian Statistical Central Commission has commenced the issuing of a new series of statistical yearbooks, of which the first is for the year 1920, issued under date of October over the signature of the president, Dr. Victor Mataja. This extremely valuable publication contains, aside from geographical data and demographic information, statistics concerning mortality, agriculture, forestry, animal husbandry, mining, industries, labor organizations, transportation, public and private credit, prices, labor conditions, law and justice, education, and public finance. In many cases the statistical information ends, however, with the year 1917–18, but there are important exceptions in which the data are brought down to the end of 1919. The demography ends with 1918, clearly indicating the extraordinary rise in mortality as a result of war conditions. The number of deaths from all causes in the Austrian Republic, returned as 119,462 for the year 1914, had increased to 166,378 in the year 1918. Even more suggestive are the statistics of birth, the number of live births having diminished in the Austrian Republic from 153,542 in 1913 to 87,594 in 1918. Of interest in this connection is a statement regarding prices, or the cost of living, best indicated perhaps by the actual price in heller of a kilogram (2.2 lbs.) of bread, the cost of which in the city of Vienna increased from 32 heller in 1914 to 476 by June, 1920. Even more startling is the increase in the price of a kilogram of flour, from 44 heller in 1914 to 1,120 in 1920. Yet these increases are insignificant when contrasted with the enormous rise in the price of lard, from 190 heller a kilogram in 1914 to 11,000 in 1920; of potatoes, from 24 heller in 1914 to 860 in 1920; of sugar, from 84 heller in 1914 to 4,200 in 1920; of roast beef, from 195 in 1914 to 9,800 in 1920; and finally, of pork, from 200 heller in 1914 to 15,000 heller per kilogram in 1920.

The number of unemployed persons, or persons seeking work, increased from 244,000 in 1918 to 648,000 in 1919. The number of persons receiving out-of-work allowances increased from 46,000 on December 1, 1918 to 87,000 on November 22, 1919, having attained to a maximum of 186,000 by May 1. In Vienna alone the number of persons out of work increased from 24,000 on December 1, 1918, to 73,000 on November 17, 1919.

The sick-fund statistics are available only for the year 1915, when 1,049,000 persons were insured, among whom there occurred 349,000 cases of sickness, involving a labor loss of 6,800,000 days and a mortality of 10,867. These sick funds had an income of 33,000,000 kronen, of which 21,000,000 was paid by the workmen, 9,399,000 by the employer, and the remainder from interest or other sources. The amount disbursed was 28,400,000 kronen, of which 11,000,000 was paid out in cash benefits, 6,000,000 for medical attention and control, 2,500,000 kronen for drugs, etc., 2,400,000 for institutional care, 924,000 kronen for funerals, and 4,200,000 for administration.

The foregoing is a brief resumé of what in the field of statistics must be considered an extraordinary achievement in view of the limitations of clerical help, the political disorganization, the want of funds, the cost of printing, etc., etc. Nothing, however, could more clearly emphasize the unhappy economic condition of the Austrian Republic while suggestive of the world's sympathy as the victim of imperial misrule and the sinister designs of the Prussian monarchy.

F. L. Hoffman

MEASURING THE BUYING POWER OF THE COMMUNITY

A Business Research meeting of the American Statistical Association was held at a dinner on February 18 at the Machinery Club in New York City. Ernest S. Bradford, who presided at the meeting, emphasized the general interest of this topic, and stated it to be the problem of business research to determine the amount of goods wanted at a particular place, as of a specified time, and how to get them there.

Dr. H. Parker Willis, discussing "Business Indices as a Factor in Measuring Buying Power," pointed out the importance of scientific method in business and the essential character of analysis of general business conditions. He explained briefly the indices which are being developed in the Federal Reserve Board at the present time, and which have a bearing on measurment of buying power, as follows:

(1) General business activity in each Reserve District as reflected by certain statistics of bank transactions. Debits to individual accounts are telegraphed weekly to the Federal Reserve Board from 161 centers. The speaker gave the opinion that these figures are superior to clearing house data.

(2) Retail trade activity as reflected from the voluntary monthly reports to the

Federal Reserve Board from about 200 department stores situated in various parts of the country.

(3) Variation in production and consumption as reflected by the physical volume of trade series, developed from reports of production, movements, or stocks on hand of certain staples in selected leading industries.

(4) A collection index, intended to show the rapidity of the turnover of funds. (For method, see article by W. H. Steiner in the December 1920 issue of the AMERICAN STATISTICAL QUARTERLY).

(5) Series on the movements in foreign trade, presenting separate indices for exports and imports.

Mr. Chester I. Barnard, director of research in the Ratemaking Department of the Bell System, discussed the methods of measuring future demand for telephones. Forecasts of the demand for residence telephones are based upon the relation between the demand for service and the standard of living. The latter is reflected in general by the mean rent of resident property. The racial and occupational composition of the population, and any other factors which contribute to fundamental changes in industry or the general make-up of the community, must be considered. This involves an estimate of the character of the population and the general standard of living, by small homogeneous areas, for a period of twenty years in the future. The object is to estimate (1) the number of telephones required in the future, for a period even twenty years hence, and (2) how this demand will be distributed by small local areas. This enables the company to locate properly the central office for a district and the main leads. Research work of this character has been going on in the American Telephone and Telegraph Company for years.

Mr. J. C. Luitweiler, of the American International Corporation, outlined the methods used by them in measuring the buying power for coffee. The problem was approached by basing future estimates upon past actual consumption and making allowance for the present curtailed buying power. The study was divided into three parts: (1) The general picture of coffee consumption in the United States and in foreign countries for a period of the past ten or twelve years; (2) estimate of the present buying power in comparison with past buying power; (3) the extent to which the present limited buying power will be devoted to the purchase of coffee.

Mr. W. H. Berridge, representing the Harvard Committee on Economic Research, discussed the relation of the condition of employment to the buying power of the labor group. A time series of unemployment was related to various other series of data and was regarded as indicative of changes in buying power.

Briefer discussion of the general topic was presented by Andrew H. Melville, director of research for the Nast Publications, who considered the subject from the standpoint of the magazine publishers, pointing out that their interest in measuring buying power centers around the selling of advertising space. Alice C. Boughton, director of research for the J. Walter Thompson Company, from the viewpoint of the advertising group, stated their primary interest to be securing purchasers for a particular product. Joseph E. Pogue, consulting engineer, pointed out the importance of the use of indices in comparing actual with potential performance, sales with sales possibilities; and in forecasting demand. The former is useful in checking past operations, the latter in planning ahead. T. K. Stevenson, sales statistician for the Western Electric Company, emphasized the importance of determining the portion of buying power which one could reasonably claim for himself, as distinguished from the measurement of total buying power. This will vary for different territories, depending upon competition and comparative contiguity to distributing warehouses.

In the general discussion from the floor emphasis was placed upon the importance of the time series in the control of business. In this manner the general trend of a business can be shown and especially the condition of the industry prevailing in time of depression. Few classes of industry fall more than 70 per cent below the normal. In a summary of the results of the discussion it was pointed out that faith in research is quite as important as imagination and technical equipment. Business must be willing to spend money for research whether the results be negative or positive. Statistical and economic prospecting is coming to be a very necessary function of a business organization.

R. E. Chaddock

FIRST FEDERAL CONFERENCE ON BUSINESS CONDITIONS REPORTING

On February 21–22 there was held under the auspices of the Division of Analysis and Research of the Federal Reserve Board, the first Federal Conference on Business Conditions Reporting, at the Hotel Washington, Washington, D. C.

The work of the conference was divided into two parts. On the first day representatives of each of the departments of the Federal Reserve Agents were present and various problems relating to the scope of the monthly review on business conditions which each Federal Reserve Bank prepares were discussed, as well as the experience of the banks with different methods of obtaining information presented in these reviews. The interchange of views which occurred resulted in making available to each bank the experiences of every other bank in connection with specific points which confront it, as well as indicating new lines of work that are being pursued in other banks and the results and difficulties in connection with such new lines of endeavor. Agreement was reached on some leading questions in connection with the preparation of the reviews, and a committee was appointed to carry on the work commenced at the conference.

On the second day there were also in attendance a number of leading business statisticians and men in academic circles interested in this type of work. It seemed desirable to obtain the opinions of "consumers" of data of this kind as to just what type of material was desirable and in what manner such material should be presented. To this end there were papers read, among others, by Professor M. T. Copeland, of Harvard University, on "The Importance of Securing Reliable Statistics on Business Conditions"; by Mr. Robert M. Falkenau, foreign trade representative of the Irving National Bank of New York, on "The Value of Work on Business Conditions to the Economic Advisers of Banks"; by Mr. F. Leslie Hayford, statistician of the General Motors Corporation, on the "Following of Business Conditions by the Corporation"; and by Mr. Carl Snyder, manager of the Statistics Department of the Federal Reserve Bank of New York, on "Interpretation of Reports on Business Conditions." General discussion was led by Professor Edmund E. Day of Harvard University. At the afternoon session it was planned to consider the actual methods employed in the preparation of certain statistical data relative to business conditions, in particular indicating the methods employed and the problems experienced by some of the Federal Reserve Banks. By thus indicating the work of the Federal Reserve System a better understanding of its efforts would be obtained, and even more complete coöperation than heretofore would be secured from the business community. The Honorable W. P. G. Harding, governor of the Federal Reserve Board, first addressed the conference on the subject of "Business and Banking," emphasizing the value of data on business conditions to the banking and the business community. The statistics on business activity assembled by the Division of Analysis and Research were then described by Dr. H. Parker Willis, director of the Division, and the banking statistics of the Federal Reserve Board by Mr. M. L. Jacobson, statistician. Mr. R. A. Cheney, secretary of the Association of Knit Goods Manufacturers, described the statistical work which the Association undertook some time ago and spoke of the interest which the industry took in these figures of production, shipments, etc. Mr. Henry Breck, assistant Federal Reserve Agent of San Francisco, then described the methods employed by his bank in preparing its monthly reports on wholesale and retail trade, and Mr. G. B. Roberts of the Federal Reserve Bank of New York described the preparation of the reports on financial conditions issued by his bank. Mr. W. H. Steiner, assistant director of the Division of Analysis and Research, reviewed the work of the Division and the special studies in Banking and Credit.

Following the presentation of the formal papers at both the morning and afternoon sessions on the second day, there was general discussion which developed many points of interest. It was generally felt that the Federal Reserve Board was in an excellent position to obtain information relative to business activity, and that the work which it had thus far undertaken should be actively prosecuted and expanded in the future.

W. H. Steiner

MISCELLANEOUS NOTES

Index of Retail Food Prices. The Bureau of Labor Statistics of the United States Department of Labor announces that hereafter its index to retail food prices will be based upon 43 articles of food and weighted according to the quantity of each article consumed by the average workman's family, as shown by the 9,000 budgets secured in 1918, instead of being computed as heretofore on the average family market basket, based upon a study made in 1901.

Since January, 1919, the Bureau has been securing retail prices upon the 43 articles of food to which its new weighting system is applied. These figures are secured on the 15th of each month from retail dealers in 51 of the most important cities. Until January, 1921, however, only 22 of the articles could be used in the cost of living index because there was no available information as to the average family consumption of the remaining articles. The family budget investigation of 1901–02 did not give the food expenditures in sufficient detail to justify a weighting upon more than the 22 articles (therefore the other articles had to be combined and used as "all others"). In the family budget investigation of 1918 a more detailed distribution of food expenditures was sought, and this gives an annual consumption per family, which can be used as food weights, on a much broader basis. Beginning with the March issue of the *Monthly Labor Review*, in which the January prices will be published, the figures will be based on the 43 articles of food. It must be understood that these new figures merely give a more detailed distribution of the total food costs. It is interesting to note that in the adjustment of the 43 articles of food to those already used by the Bureau for the 22 articles, the variation in the index number was but four-tenths of one per cent.

Index of Wages. The Bureau of Labor Statistics of the United States Department of Labor has made public a general index of wages per hour from 1840 to 1920 based upon hourly wages in 1913 as 100. It is fully realized that the material for computing such an index is disconnected and far from complete. For many years there has been hesitation as to the propriety of announcing an index of this character, but the importance of having a general wage index that might be used for comparison with similar index number changes in cost of living and wholesale prices has determined the Bureau to go over the mass of material and prepare such an index. Although not claiming for this the same degree of accuracy that attaches to the work of the Bureau in investigations where all the material is gathered and compiled within the Bureau, yet it is believed that the table is based upon data essentially correct. At all events, the very best available material has been used and the table is the best that can be constructed upon this material. The tabulation showing index numbers of wages per hour, 1840 to 1920, is as follows:

INDEX NUMBERS OF WAGES PER HOUR, 1840 TO 1920
(Currency basis during Civil War period)
(1913 100)

Year	Index number	Year	Index number
1840	33	1910	93
1850	35	1911	95
1860	39	1912	97
1865	58	1913	100
1870	67	1914	102
1875	67	1915	103
1880	60	1916	111
1885	64	1917	128
1890	69	1918	162
1895	68	1919	184*
1900	73	1920	234†
1905	82		

* This index number applies to the spring of the year. Wage rates advanced during the year.
† This index number applies to the summer of 1920, and probably represents the wage peak of the year.

International Labor Review. The first number of the *International Labor Review* has been received in this country. It is edited by the International Labor Office under the League of Nations. In the first issue, January, 1921, there are a number of special articles and, in addition, six sections: Industrial Relations; Production, Prices and Cost of Living; Unemployment; Protection of Women and Children; Coöperation; and Agriculture. The special articles include accounts of the International Labor Organization by Albert Thomas, its director, and of the International Trade Union movement and its relation to the Labor Office, by J. Oudegeest, secretary of the International Federation of Trade Unions. Sidney Webb contributes an article on the "Process of Amalgamation in British Trade Unionism," and John R. Commons discusses industrial government. This issue contains 150 pages and is devoted to many different aspects of problems of labor in various countries.

The Advisory Census Committee. The Advisory Committee to the Director of the Census, appointed in 1919 by the American Statistical Association and the American Economic Association at the request of the Secretary of Commerce, has been asked to assume additional duties. At the request of the Chairman of the Senate Committee on the Census, it has taken under consideration the methods of apportioning representatives. The committee met in Washington on March 11 and 12 to examine the mathematical and statistical aspects of the problem. The meetings were attended also by Professors A. A. Young, E. V. Huntington, Irving Fisher, F. W. Owens, and Dr. J. A. Hill. A report to the Senate Committee is now in preparation. This same committee, with the addition of Professor A. A. Young, will serve also as an Advisory Committee on Statistics to the Department of Commerce, in compliance with a request from Secretary of Commerce Hoover. Two annual reports of the Advisory Committee have been published in the QUARTERLY, Vol. XVLI, pp. 76–107 and 465–83.

Occupational Classification of Railroad Positions. The United States Railroad Labor Board recently prepared a comprehensive functional occupational classification of railroad positions as a basis upon which monthly reports are to be made by railroads to the Interstate Commerce Commission and to the Labor Board. With the establishment of this classification and the institution of the reporting forms and rules which the Board has developed in addition to the classification proper, railway wage statistics will be put upon a sound statistical basis and the data reported will be made of service for administrative and public purposes. The Interstate Commerce Commission has formally approved the forms and rules and has issued a wage order making them effective for reports on July 1, 1921. It has also approved the classification and has made it the basis for assigning positions in the reports.

A Clothing Survey. The clothing survey made in coöperation with the National Association of Retail Clothiers by the Bureau of Business Research of the Northwestern University School of Commerce, under the direction of Dr. Horace Secrist, has been completed. The report of this survey is to be published in six volumes, and will cover such topics as Sales and Sales' Ratios in Retail Clothing Stores; Expenses and Expense Ratios, including rent, wages, bushelling, and general and total expenses; Advertising Methods and Expenses; Purchase Discounts, Inventories, Average Stock and Stock Turnover; and also a study of clothing stores as operating units.

Public Health Committee. The Committee of the American Public Health Association has for some time been collecting information regarding the public health procedures in American cities. The field work is now practically completed and surveys of eighty-three cities are being compiled. The Committee will issue its report within the calendar year.

A special dinner-meeting of the American Statistical Association was held in the dining rooms of the Metropolitan Life Insurance Company, New York City, on Friday evening, April 15. Sir Arthur Newsholme, K. C. B., an honorary member of the Association and lecturer on Public Health Administration at the Johns Hopkins University, formerly Principal Medical Officer of the Local Government Board of London, was a guest of the Association and spoke on the topic, "The Better Use of Vital Statistics in Public Health Administration." In his address Dr. Newsholme spoke with keen insight of the public health administration in the United States and showed a sympathetic understanding of our successes, difficulties, and shortcomings. At the conclusion of the address, one after another of the members of the Association arose to pay tribute to Dr. Newsholme and the services he has rendered the cause of public health. Dr. Newsholme has been in this country for two years, lecturing at the School of Hygiene and Public Health of the Johns Hopkins University. He has also visited various states and has been a great constructive force in stirring up public health activities. He sailed for England on April 16.

A special meeting and dinner of the Washington members of the American Statistical Association was held in Washington, D. C., on April 8. The program consisted of two papers: "National Income," by Wesley C. Mitchell, director of the National Bureau of Economic Research, New York; and "A Proper Distribution of Credit between Consumption and Investment," by Franklin T. Miller, Washington, D. C.

Dr. R. B. Robbins, assistant professor of Mathematics and Insurance at the University of Michigan, is on leave of absence during 1921 and is now serving as assistant actuary in the office of the Superintendent of Insurance of the State of New York at Albany.

Mr. William M. Steuart has been appointed director of the Census to succeed Mr. Samuel L. Rogers.

James W. Glover, professor of Mathematics and Insurance at the University of Michigan, has been made a member of the Committee on Mathematical Analysis of Statistics, originally appointed by the National Research Council.

Mr. F. Leslie Heyford, formerly in the Wilmington office of the Du Pont de Nemours Company, has joined the staff of the General Motors Corporation in New York City.

The editors announce that commencing with the June issue of the QUARTERLY PUBLICATIONS the Association will furnish without charge fifty reprints to contributors of articles.

COMMITTEE APPOINTMENTS

Committee on Fellows:

John Koren appointed for five years, to take the place of Frederick L. Hoffman, whose term expired 1920.

The full committee is as follows:

Adna F. Weber,	term	expires	1921
Edward L. Thorndike,	"	"	1922
Carroll W. Doten, Chairman,	"	"	1923
Leonard P. Ayres,	"	"	1924
John Koren,	"	"	1925

Committee on Institutional Statistics:

Edith Abbott
Kate H. Claghorn
Edith M. Furbush
Joseph A. Hill
Robert M. Woodbury
Horatio M. Pollock, Chairman

Joint Committee on Statistics of Marriage and the Family:

Edwin W. Kopf, representing the Statistical Association.

Committee on Business Research:

Ernest S. Bradford, formerly director of Business Research, The McGraw Hill Co., organizing Chairman of the Committee
Chester I. Barnard, American Tel. & Tel. Company, representing the Public Utilities group
C. S. Duncan, Southern Wholesale Grocers' Association, representing the Merchandising group
L. K. Frank, New School for Social Research, representing the Economic Research group
F. Leslie Hayford, General Motors Corporation, representing the Manufacturers' group
C. A. Hoppock, H. K. McCann Company, representing the Advertising Agencies
A. H. Melville, The Nast Publications, representing Publishers

E. H. Naylor, Writing Paper Manufacturers' Association, representing Trade Associations

Richard Webster, Geo. Batten Company, representing Advertising Agencies

H. Parker Willis, Division of Analysis and Research, Federal Reserve Board, representing Banking and Credit Institutions

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NEW MEMBERS ELECTED SINCE JANUARY 1

Corporate Members

Metropolitan Life Insurance Company, 1 Madison Ave., New York

Washburn-Crosby Company, Minneapolis, Minn.

Regular Members

Alford, Clarence L., 1108 Independent Life Bldg., Nashville, Tenn. Statistical work with Mr. Abb Landis

Alldredge, E. P., secretary, Survey, Statistics & Information, Southern Baptist Convention, Nashville, Tenn.

Anstie, Miss Lillian F., S. K. F. Industries, Inc., 165 Broadway, New York. Preparation of financial statistics

Anderson, Leo Dewey, Bureau of Personnel Research, Carnegie Institute of Technology, Pittsburgh, Pa.

Bernstein, Alton F., Public Service Commission, 48 Lafayette St., New York

Bivins, Percy A., The Standard Textile Products Co., 320 Broadway, New York

Blood, John Balch, 804 Interstate Commerce Bldg., Washington, D. C. Valuation Analyst on Railroads, Interstate Commerce Commission

Brissenden, Paul F., New York University, Washington Square, New York. Assistant Professor of Economics

Brown, Lathrop, the St. James, New York

Brown, Theodore H., Dept. of Statistics, Brown University, Providence, R. I.

Bullis, H. A., Chief Statistician, Washburn-Crosby Co., Minneapolis, Minn.

Burgess, Mrs. May Ayres, secretary, Education Dept., Russell Sage Foundation, 130 E. 22d St., New York

Camp, Burton H., Dept. of Mathematics, Wesleyan University, Middletown, Conn.

Cassidy, Henry L., American Statistical Service Co., Holyoke, Mass.

Cathles, Laurence M., vice president and actuary, Southland Life Ins. Co., Dallas, Texas

Cole, Fred J., public accountant, 1237–38 City National Bank, Omaha, Neb.

Cowen, A. Y., Miller & Co., 120 Broadway, New York

Davis, Robert M., statistical editor, *Electrical World*, New York

Foster, William T., director, Francis D. Pollak Foundation for Economic Research, 109 Sargent St., Newton 58, Mass.

Freyd, Max, research fellow, Bureau of Personnel Research, Carnegie Institute of Technology, Pittsburgh, Pa.

Gantt, Miss Margaret E., Statistical Bureau, Metropolitan Life Ins. Co., 1 Madison Ave., New York

Hart, William A., Sales & Market Analysis, Frank Seaman Advertising Agency, 470 Fourth Ave., New York

Hartke, Geo. W., general accounting analysis, 400 Benedum-Trees Bldg., Pittsburgh, Pa.

Horney, Chas. J., 37 E. 28th St., New York. Business statistics

Hourwich, Iskander, Engineering Division, U. S. Army Air Service, McCook Field, Dayton, Ohio

Hulst, Miss Myra M., Health Service Dept., American Red Cross, Washington, D. C.

Hyde, Arthur J. W., secretary-treasurer, L. A. Thompson Scenic Railway Co., 220 W. 42nd St., New York

Jones, Herschel H., director, New York City Office, Division of Foods & Markets, 90 West Broadway, New York

Kattenhorn, Arthur W., Statistical Dept., American Tel. & Tel. Co., 195 Broadway, New York

Little, John Dutton, editor, United States Bulletin Service, 10 Jackson Place, Washington, D. C.

Magnusson, Leifur, Bank of Commerce, 31 Nassau St., New York

Michell, Humfrey, Dept. of Economics, McMaster University, Toronto, Canada. Member Royal Statistical Society

Mitscher, Harry A., Prudential Ins. Co., Newark, N. J.

Neubauer, Charles M., Byrnes & Baker, C. P. A., 52 Wall St., New York

Outhwaite, Leonard, Bureau of Industrial Research, 289 Fourth Ave., New York. Also instructor in Personnel Administration, Columbia University

Plimpton, R. E., chief, Service Dept., The Engineering Magazine Co., 120 W. 32nd St., New York

Raines, Lester C., 102 State Hall, University of Pittsburgh, Pittsburgh, Pa.

Read, Edmund D., Statistical Dept., American Tel. & Tel. Co., 195 Broadway, New York

Rich, Gilbert J., Dept. of Psychology, University of Pittsburgh, Pittsburgh, Pa.

Riggleman, John R., Instructor in Business Statistics, Harvard Graduate School of Business Administration, Cambridge, Mass.

Roa, Emeterio, 209 S. Thayer St., Ann Arbor, Mich. Student at University of Michigan

Rogers, Herbert W., instructor in Psychology, Psychological Laboratory, Yale University, New Haven, Conn.

Rose, William M., Market Investigation and Reports, 60 High St., Boston, Mass.

Ryan, Andrew H., director, Industrial Hygiene, Scovill Mfg. Co., Waterbury, Conn. Lecturer, Industrial Physiology, Yale University

Schuckman, F. E., Homestead Valve Mfg. Co., P. O. Box 1754, Pittsburgh, Pa.

Smead, E. L., chief, Division of Reports & Statistics, Federal Reserve Board, Washington, D. C.

Strong, Benjamin, governor, Federal Reserve Bank, 15 Nassau St., New York

Towns, Charles H., Low, Dixon & Co., 37 Wall St., New York. Investment banking

Tucker, E. H., 832 Van Nuys Bldg., Los Angeles, Calif. Economic statistician, with First Nat'l Bank, Los Angeles Trust & Savings Bank, and First Securities Company of Los Angeles, Calif.

Uhrbrock, Richard S., teaching fellow in Psychology, Carnegie Institute of Technology, Pittsburgh, Pa.

Working, Holbrook, University Farm, University of Minnesota, Minneapolis, Minn. Research in Agricultural Economics

REVIEWS

The Fall of the Birth Rate. A paper read before the Cambridge University Eugenics Society, 20 May, 1920. By G. Udny Yule. Cambridge: The University Press. 1920. 43 pp.

The lecture which is published in pamphlet form was planned, as the prefatory note explains, not as an original contribution but rather to offer to a non-technical audience "an exposition of matters already known and views previously expressed." In the first and more substantial part of the lecture Mr. Yule examines, in this spirit, the historical trend of British birth statistics since 1851. His discussion of the allowances which should be made, in the study of birth rates, for changes of age and of marital condition in the population serves well to exemplify two useful and accepted statistical methods—the standardized birth rate devised by Drs. Newsholme and Stevenson, and his own adaptation of Professor Tait's formula relating fertility with age. He reviews the interesting results of some recent attempts by English investigators to determine the different rates at which fertility has declined in different social classes. Proceeding thus, he arrives anew at familiar and generally approved conclusions: that a pronounced decline of the birth rate has been in progress in England since 1876; that it has been more marked in the upper and professional classes; and that it represents in the main a real decrease in the fertility of married women.

But at this point Mr. Yule breaks with prevailing opinion; for in interpreting the decline of fertility he concedes only a minor influence to the deliberate and volitional control of fertility by contraceptive practices. His argument in support of this position is superficial and unsatisfactory. It appears to rest largely on a very dubious inference from precarious evidence laid before the National Birth Rate Commission, and on a more than dubious interpretation of a reference in the report of the Commission to some of Mr. Sidney Webb's data on family limitation, first published in the London *Times* in 1906, and since then embodied in Fabian Tract No. 131 on *The Decline in the Birth Rate.* Mr. Yule seems not to have consulted the Webb study in the original, although he has ventured to cite it in support of a view at variance with the conclusions of both Mr. Webb and the Birth Rate Commission. He has virtually ignored the important foreign literature of his subject; and in many incidental ways he reveals that he is on unfamiliar ground, as, for instance, when he implies that voluntary control of births could not have had a significant influence on the French birth rate before 1875.

As affirmative argument in favor of his contention Mr. Yule adduces two conjectures to the effect that the fertility of a nation is subject to natural fluctuations. One is Dr. Brownlee's hypothesis of the variation of germinal vitality. The other is Mr. Yule's own belief in an undefined but significant relation between fertility and the economic cycle. What this relation is he frankly admits himself unable to state, though it seems to him a largely unconscious psychological response to economic conditions. The evidence of some of his earlier statistical studies suggests to him a correlation between national fertility and the general level of prices. But the correlation, as he recognizes, has latterly broken down; and one ventures to remark that even had it not broken down it would have been susceptible of many different interpretations.

No reflecting person would contest Mr. Yule's assertion that the fact that contraceptive measures are used is not a satisfactory explanation of the motives for using them. Moreover, whatever be the reasons for their use, it is quite possible that we have been led to exaggerate the effect of such measures in lowering the birth rate. It is much to be desired that some highly qualified statistician should searchingly re-examine the record, and should challenge the prevalent interpretation if it appears to be mistaken. But if such a challenge is to be taken seriously it must be based on stronger evidence and sounder argument than this pamphlet offers us.

James A. Field

The University of Chicago

Argentine International Trade Under Inconvertible Paper Money—1800–1900, by John H. Williams. Cambridge: Harvard University Press. 1920. xiv, 282 pp.

The author's object in writing this study of the international trade of Argentina has been to examine the inter-relations of three factors—paper money, borrowings, and trade—and thus to make inductive examination of the theory of international trade under a régime of depreciated paper. After an introductory analysis of the purpose of his study, he gives a long review of the monetary and commercial history of Argentina. This is not completed until the close of Chapter X. Thereupon he recurs to the theoretic side of the investigation and considers the effect of inconvertible paper on international trade balances. Following a chapter on that phase of the matter is a study of Argentine foreign trade which is continued up to the end of the book. Chapter XVI, entitled "Conclusion," restates a few of the main points and sets them forth in their theoretical relations. A detailed bibliography and a thorough index complete the volume.

It would probably have been better if Mr. Williams had simply presented his study as a history of Argentine currency and foreign trade during the years he has studied. The form in which the undertaking is stated at the outset and the suggestions thrown out from time to time in the course of the work give the reader the impression that the real or chief object of the writer is to afford a critical exposition of theories of foreign exchange and prices as "inductively" examined. The student of foreign exchange is thus impressed by the scantiness of the material supplied under these heads and is inclined, therefore, to adjudge the volume a disappointment when he reaches the end and finds the author still fencing with the theoretical issues involved and still disinclined to furnish the concrete conclusions promised at the outset. Yet to the reader who is willing to strip off the husks and take the study for its content the book has both merit as a piece of economic inquiry and value as an addition to commercial annals.

There is much detailed and careful review of Argentine history in this monograph, but it is scarcely practicable to present even the basic elements of it within brief space. The early monetary and commercial experience of Argentina is carefully sketched and then the author turns to a survey of public loans and the balance of "international payments." He next presents a history of the national banking system of Argentina and explains the origin of the speculative movement of the years 1885–1890. Turning then to the Baring Panic and the international financial troubles of the early nineties, the study passes in review the various factors which led to paper money depreciation. Later trade developments, the reformation of monetary conditions, and the development of individual exports are considered with equal care. It is a painstaking outline of the economic history of a country whose currency and price experience have been most interesting and whose lessons have been too little studied by English and American economists.

In so far as Mr. Williams reaches "theoretical" conclusions, they are of a nature which might about as well have been taken for granted at the outset. An example of this sort is seen in Chapter X on the relation between the value of paper money and the balance of international payments. Here he finds that the balance of international payments "did in fact exercise a powerful influence upon the value of Argentine inconvertible paper money." How any one could question this statement it would be difficult to see. This, as current experience in European exchanges clearly shows, is merely a special case of the law of demand and supply and the method of its operation, as has been repeatedly pointed out in current discussion of the exchange question. Another example of a similar, although not precisely parallel, sort is found in Mr. Williams' statement that Argentine experience in the export trade does not suffice to verify current theories with regard to the effect of a rising gold premium upon exports. Such a premium Mr. Williams believes has been currently regarded as furnishing a stimulus to exports. He finds that "such a stimulus was undoubtedly present," but owing to the operation of other factors the gold premium did not produce any marked increase in export trade; in other words, it was not possible to institute any such close comparison between the different classes of figures as had been desired.

Taking the book as a whole, it is concluded that data which have been surveyed indicate "a pretty general correspondence with theoretical reasoning." Especially clear-cut, the author thinks, is the relation between the balance of international payments and the value of inconvertible paper money. General conclusions with reference to the effect of the paper money experience upon the people of Argentina are expressly disclaimed as being "extremely difficult to verify." Expressions like these tend to stimulate in the reader's mind the thought that the book was originally projected upon too ambitious a scale and does not fulfil its promise, or at all events, fulfils it only in a negative way. This, as already stated, does not in the least detract from its merits as a careful study of economic conditions affecting the exchange and foreign trade of Argentina over the period to which the volume relates.

H. PARKER WILLIS

Agricultural Prices, by Henry A. Wallace. Des Moines, Iowa: Wallace Publishing Company. 1921. 224 pp.

This book proposes a new method of determining the prices of agricultural products —a plan whereby the statistical economist and the production engineer will replace speculative traders as the agents of price determination, and in which it becomes the main function of prices to guide production rather than to reflect the merely immediate and temporary conditions of demand and supply.

The main fault with the present price-registering system is its disregard for long-time cost-of-production price. The changes in the price of hogs, for example, instead of bearing some constant relation to cost of production are only the response of the market to the day's receipts of hogs, to the seasonal demand for pork, and to the strategy of the packers. Cost means the industrial requirements of production, expressed in pecuniary terms. Thus, the basic industrial fact about the production of hogs is that it requires approximately 11.5 bushels of corn to make 100 pounds of hog. This is the corn-hog ratio, and "this ratio is cost of production in the very truest sense of the term" (p. 11). The experience since the Civil War has shown that when prices are averaged by decades "hogs have sold on the Chicago market at a price per hundred weight equal to the Chicago price of 11.5 bushels of corn" (p. 28). The actual price from day to day and from month to month, responding to the surface indications of supply and demand, have fluctuated above and below this "right price" as indicated by the ratio. Supply, demand, and price being mutually interdependent, the adjustment of price merely for the purpose of clearing the day's market results in violent fluctuations in the weekly shipment of hogs, in needless disturbances of the consumer's demand for pork, and in price aberrations inconsistent with the necessary cost of production.

Economic theory has ordinarily assumed that the price (actual) which clears the market is also the price (normal) which will best guide production; the author, however, holds that the two prices are not identical, and he prefers the method of price determination which will keep in mind the second function. He does not minimize the inherent difficulties of dealing separately with the two functions. Once the primary purpose in establishing a price becomes the stabilization of the conditions of production, then the other function of adjusting the current demand to the current supply may need to be performed by some machinery other than price changes. Perhaps a coöperative selling organization would control the flow of the product to market; or cold storage facilities would be used to smooth out the unavoidable irregularities in production and consumption; or even, if necessary in order to stabilize the live-stock industry, perhaps meat products would be sold at a loss for a season to be offset by more profitable prices at a later time. Whatever the substitution, it must at least be evident that prices of corn and of hogs which one year break up herds and bring brood sows to market and which next year hold out false promises to the feeders, no matter how effective they may be as means of equating demand and supply, cannot be regarded as satisfactory guides to production.

Given the present method of price determination, the author believes farmers should organize for collective bargaining. They should reduce their crops at strategic moments, as business concerns curtail output when large production is unprofitable; they should ask, as does organized labor, "At what season of the year is it best to strike?" When once the farmer is as effectively organized as are the other parties to the market controversy, the futility of sabotage may become apparent, and possibly all classes may "unite in production as a source of profit, rather than on clever bargaining" (p. 17).

Such a coöperative arrangement between classes, however, the author believes to be impossible under the present *laissez faire* competitive price system. Owners will not permit their plants to be operated at capacity unless they have some assurance that they will not be penalized by falling prices and pecuniary losses. The author offers the ratio method of price determination as a possible solution. He looks to the economists for statistical inquiries which will measure the failure of present prices to perform their functions and which will serve as a basis for a better method of control. Thus, the author turns from the *laissez faire* economist to the statistical economist, and from the business man to the production engineer.

WALTER W. STEWART

Amherst College

The Financial Policy of Corporations, by Arthur Stone Dewing. New York: The Ronald Press Co. 1920. V vols.

The five volumes of Dewing's *Financial Policy of Corporations* are entitled *Corporate Securities, Promotion, Administration of Income, Expansion,* and *Failure and Reorganization.*

When the reviewer had completed the first of these five volumes, he was convinced that he was in the midst of the finest study in the field of corporation finance that had ever been made in the United States. In the text there is a good, straightforward statement of the principles and conclusions determined upon, and in the copious footnotes are adequate examples and evidence for the generalizations above. With the exception of the treatment of preferred stocks and of the definition of capital (to be discussed in later paragraphs), there is little to criticise in the first volume. Many parts of the other four volumes, however, are not up to the standard set by the first: the footnotes are less copious, and the text not always so convincing. One feels that the material is often thin, and that it could have been compressed into less than five volumes. However, the five volumes as a whole represent the best study in corporation finance that has been made, and the student can well afford to spend the extra time and money demanded.

Most of the statistics presented are not complicated and call for no comment. In Volume III (p. 93) there is one use of statistical data that is very questionable. In order to prove the general principle that the earnings of companies which manufacture inexpensive consumption goods are more regular than the earnings of companies engaged in the manufacture of expensive production goods, the author compares the earnings of the Diamond Match Company with those of the American Locomotive Company. Obviously, even if these two companies had been equally well managed—which, the reviewer is informed, is open to serious question—the evidence furnished by their earnings is insufficient for statistical proof. The principle is certainly logical, but the meager data should have been used merely as a footnote, with all apologies to the statistician, and with the statement that further evidence would be necessary before the generalization could be statistically proved.

Some of the economic theory expounded in the early chapters of Volume IV (*Expansion*) might have been discarded or substantiated had statistical evidence been sought for or adduced. The Federal Trade Commission in some of its studies (see especially the Canned Salmon Report) has begun to obtain statistical data on the costs of various sized plants and companies; the inclusion of such data would have been, to say the least, illuminating.

In a footnote in Volume III (p. 16), the Bureau of Corporations' Steel Report is referred to as "somewhat biased against the corporation investigated." Although the government's investigators may be anxious to find something to criticise, they undoubtedly obtain facts to which an individual cannot have access. In this connection the reviewer is tempted to recall that in Dewing's *Corporate Promotions and Reorganizations* there is a criticism of the Steel Report because it often fails to give a reference or an authority for its statements; obviously, the agents of the Bureau of Corporations were not constrained to depend upon what some man told them, but had original records as evidence. Furthermore, just as the point of view of the government may be "biased," so Dewing's is often just as biased, but in the other direction. The student, who obtains his information from interviews and published reports, should take what he receives with a grain of salt unless he has access to the books of the man interviewed. Dewing's treatment of trade associations, of blue sky stocks, and his belief in the authenticity of published accounting statements suggest the attitude of the conservative, honest investment banker rather than that of the critical economist.

Probably the most serious criticism of *The Financial Policy of Corporations* is the treatment of industrial preferred stocks. The author seems to have a curious prejudice against these securities: in one place, he suggests that they have not been in existence long enough to warrant a judgment as to their value; in other places, he implies that they are bad investments. He underestimates the cumulative and retirement features. He gives little or no attention to those important preferred stock provisions which make it impossible to put any liens ahead of the preferred issue. Finally, he thinks that the preferred stockholder is a partner, not a creditor. A study of the bulk of the industrial preferred stocks should immediately disclose that there is little difference between this type of security and the bond, particularly if the bond rests on the general credit of the company and not on a specific mortgage. The preferred dividend is merely a high rate of interest, explained by the risk involved. In one place he practically admits that the sinking fund provision makes an issue of preferred seem very much like a funded obligation of the owners, but he fails to recognize that the distinction between the common stockholder and the preferred stockholder is usually almost as definite as the distinction between the common stockholder and the bondholder. The preferred stockholder's right to vote, contingent upon the non-payment of dividends, is no reason for classifying him with a voting common stockholder, but rather with the mortgage bondholder, who has the right to foreclose if he is not paid his interest.

In Volume III there are some extended discussions of the problems of accounting. Much attention is given to depreciation, which is considered a deduction from gross profits in order to reduce gross to net profits. Depreciation, it seems to the reviewer, ought to be included in costs before any kind of profit (economic or accounting) is reached. Depreciation is the cost of fixed capital goods and would be little different from "Raw Materials" (current capital goods) if the accountant did not arbitrarily use a year as a fiscal basis. An economist, giving as much space to accounting problems as Dewing gives, should have presented a more analytical treatment of the problem of revaluing the capital goods on the balance sheet and to the distinction between economic and accounting profit, particularly because these questions and similar ones have a close connection to the interpretation of financial data. In the first pages of the first volume the difficulties encountered in the use of the words capital and capitalization are expressed. It may not be out of place here to suggest two or three definitions which might have helped to clarify the author's interpretation of accounting data. Capital (the basis of the interest charge) might be defined as *postponed claims on consumption goods expressed in terms of money.* Capital is transferred by its owner, the capitalist, to the entrepreneur, who uses it to purchase capital goods and to pay wages, interest, and rent. Dewing, like most writers, uses capital to mean what is here defined as capital goods, or even worse, fixed capital goods. The definitions set forth in the foregoing sentences help to explain why the accountant insists on the original cost of the assets on the balance sheet rather than revaluations, especially when he is using the balance sheet for a determination of the investment or the capital which is to serve as a basis for the interest charge or for the measurement of return (economic profit and interest). New capital injected or profits earned and left in the business also represent postponed claims and are the only additions that should be made to the capital or investment. Capitalization, it seems to the reviewer, should be restricted to mean the sum of the stocks and bonds, and should be definitely distinguished from capital. If the assets were reappraised or goodwill injected, more stock might be issued or the surplus might be written up, but no more capital would be thereby created.

It would be unjust to end this review without some commendation of Professor Dewing's scholarship and without restating the importance of his contribution to the field of corporation finance. The reviewer felt that it would be more practicable in the space allotted (and more valuable for the critical reader) to call attention to what seemed to him the faults of this study; its good points are so numerous and will be so apparent to the reader that no comment seemed necessary. KEMPER SIMPSON

Department of Agriculture

Government Control of the Sugar Industry in the United States, by Joshua Bernhardt. New York: The Macmillan Company. 1920. x, 272 pp.

A volume which narrates the history of a war-time policy can serve only a peace-time purpose. It is the privilege of the amateurs who will manage future wars to disregard all experience and to muddle things for themselves, even as we did before them. Mr. Bernhardt probably had no thought of putting into the hands of future belligerents a valuable contribution to the literature of economic organization for war. Even if he did, there is little prospect that his volume will carry across the years to a future sugar control board. But none the less, the book is important because of its contribution to our very imperfect understanding of our industries, and of the technical problem of controlling them in such a way as to make them serve appointed ends. Excluded from the laboratory, denied the use of the experimental method, and unable to determine in advance of the fact the consequences of a definite procedure, we should welcome as a windfall the mass of material about the organization of industry and the effects of various methods of controlling it which the war has given us.

Among such contributions the story of the control of sugar is among the most significant. The problem which it presents is a fair sample of the problems involved in the control of industry to a purpose. The period of time, much briefer than the scholars would have had it, is ample for at least a tentative statement of problems. The account given by Mr. Bernhardt is objective enough to warrant careful attention. Despite its authorization by the United States Sugar Equalization Board, it is a straightforward story, so free from bias as to be almost dull. The 128 pages of text are for the most part a running narrative, littered here and there with documents and statistics. And enough of this crude raw material is left to cover 134 pages of appendix.

The narrative covers in detail the three periods into which the history of the control of sugar during the war is to be divided: (1) The period of "voluntary coöperation of various branches of the sugar trade" under the general oversight of the Sugar Division of the Food Administration; (2) the period of the centralized administration of the distribution of sugar by the United States Sugar Equalization Board; and (3) the period of the disturbed and hesitating "demobilization of sugar control" which followed the armistice. Of these the second has the larger meaning for the student of economic organization and deserves careful study. It represents an attempt to secure an equitable distribution of sugar by unified administrative judgments based upon accurate and comprehensive statistical data. A study of policy during this period involved a consideration of (1) the ends which the Board tried to achieve; (2) the general industrial conditions which set the terms of the problem; (3) the methods that were employed; and (4) the results that were effected.

The aims of the sugar administration, reduced from Mr. Bernhardt's very comprehensive list, were: (1) To effect a proper distribution of sugar between ourselves and our allies; (2) to secure an equitable distribution among different sections of the country and different groups of the population; (3) to keep the price of sugar within the reach of the ordinary consumer; and (4) to maintain the largest possible production of this staple commodity. It is evident that these aims were more or less contradictory, and that the purpose of the Board was to secure the best relative realization of them.

The great difficulty of the problem lay in the unusual conditions prevailing in the sugar industry. The war had closed the sugar fields of Central Europe and had left England and France without their customary supply. The dearth of shipping had placed the supply from Java beyond reach. The Allies, accordingly, turned to the West, particularly to Cuba, where the crop was threatened by an insurrection. More important still, since the supply available in late summer and early autumn was most seriously curtailed, the seasonal distribution of the product was seriously disturbed. And, lest the problem escape complications, the coming of prohibition had increased the demand for sugar just at a time when the supply of labor for sugar production was decreasing and costs were rapidly rising.

The policy of the sugar administration aimed at a quick adjustment of the distribution of sugar to these new conditions through a unified control of the supply. First, a comprehensive statistical survey was made of the production and the probable future demand for sugar. Second, by purchase of the Cuban crop and other devices, the Board obtained a nominal control of the whole supply and could allocate it in terms of the country's needs. Third, an apportionment of the supply between ourselves and our allies was effected. Here the scarcity of shipping, which imposed a limit upon the amount which Europe could take, made the problem easy of solution. Fourth, a single uniform price for the refined domestic product and a series of differential prices to the growers in Cuba, Porto Rico, Hawaii, Louisiana, and Michigan were established. The differentials included such items as carriage, import duty, and refining. The solution of each of these problems involved a weighing of many values and a consideration of a vast amount of information presented in quantitative form. Thus, in fixing the price of sugar the Board aimed, on the one hand, to avoid profiteering, and, on the other, to stimulate production. To hit upon the price which would best protect the consumer without seriously threatening the supply, the amounts likely to be available at all possible costs had to be approximately determined.

The descriptive task essayed by Mr. Bernhardt causes him to refrain from a judgment upon the success of this venture into national control. But the net effect of the narrative upon the reader is to raise certain questions which he finds himself unable either to answer or to dismiss. When conditions are changing rapidly, is administration by a centralized agency to be preferred to adjustment "by the natural workings of the price system"? Which of the two is quick and effective, and which imperfect, vacillating, and tardy? Is not the efficiency of the distribution of a commodity by the "trade" effective just to the extent that conditions remain the same and distribution follows routine paths? Could the distribution be improved and the commodity offered for less if a centralized statistical service which gathered all the facts was maintained? How far would a centralized allocation of the product help matters? The evidence presented by Mr. Bernhardt does not make out a case for a change from the present system; but it does create so strong a presumption in favor of a more centralized control, based upon an adequate statistical service, that it requires further examination.

In this connection the evidence afforded by the failure of the government to purchase the Cuban crop for 1919–20 and the consequences of the failure are not without significance. Had the government purchased the crop, the price would doubtless have advanced and we would have had conclusive evidence of the failure of "administrative control." But the events which followed in the wake of "letting sugar alone" through dearth and high prices, gave abundant evidence that the workings of unregulated industry are not always so perfect as to be automatic.

Walton H. Hamilton

Amherst College

Report on the Mortality from Influenza in England and Wales during the Epidemic of 1918–1919. Supplement to the Eighty-first Annual Report of the Registrar General of Births, Deaths and Marriages. London: H. M. Stationery Office. 1920. 119 pp.

The epidemic of influenza caused nearly 200,000 deaths in the civilian and military population of England and Wales during the forty-six week period, June 23, 1918, to May 10, 1919. Among the civilian population alone it was estimated that 184,000 deaths occurred. The rate of mortality for the forty-six week period was practically 6,400 per million of population.

The epidemic appeared in three principal waves or phases. The first wave began in the last eight days of June, 1918, reached a maximum in the week ended July 18, and subsided about the first of September. The second wave or phase began about the third week in September, rose to a maximum in the week ended November 9, and attained the minimum toward the last of the following January. The late winter and spring wave had its onset about February 1, the maximum in the week ended March 1, and the minimum approximately in the week ended May 10. Among the civilian population the death toll of the summer quarter of 1918 was estimated to be 17,500, during the last quarter of 1918, 115,000, and during the period January 1 to May 10, 51,500. Some 14,000 deaths from influenza and its consequences were experienced in the military establishment in England and Wales during the forty-six week period.

The detailed general tables in the report are introduced by a statement of the several methods used in estimating the epidemic damage for the forty-six week period. A tabular review of the age distribution of deaths from influenza in a "standard" female population, for the years 1847 and 1848, and for each year from 1890 to 1918, is then shown. Proportions of influenza deaths at five-year age groups in the calendar quarters of 1918 and in the first quarter of 1919 are given to display the unusual age incidence of the prevailing disease. The type of influenza which occurred during the first twenty-five weeks of 1918 seemed to affect chiefly young children and old people; but toward the end of June an abrupt shift in the age incidence of the disease occurred. A sudden increase in the proportion of deaths at the age group 15 to 24 years was observed; then, as the summer epidemic approached the peak, the age ranges between 25 and 35 years were most affected. The same phenomenon of an increase in the proportion of deaths in adolescence was noted at the outbreak of the autumnal and most violent phase of the epidemic. During the week of maximum death rate, the week ended November 9, the proportion of deaths was highest in the age division 20 to 30 years.

From the evidence submitted in the report it would seem that the northern areas were first affected, and that in the first wave the mortality decreased from north to south. The second wave began approximately in the week ended September 28, about two weeks later than the commencement of the epidemic in the northeastern part of the United States (week ended September 14). The interval between the second and third waves was much shorter than that between the first and second. During the first intermission in the late summer of 1918, the epidemic mortality remained below 2 per 1,000 for eleven weeks, while the intermission was only five weeks between the second and third waves.

An interesting section (pp. 27–30) is devoted to tables of crude data on the possible relation of influenza damage to such factors as wealth, general health conditions, and the prevalence of other infectious diseases. Tables on diseases and conditions complicating influenza are then displayed. An important table (XVIII) is shown on the proportion of influenza deaths associated with puerperal diseases and conditions. A graphic section (pp. 38–47) illustrates some of the general tables discussed in the introductory section of the report. Table XX (pp. 48–80) records the number of influenza deaths, and death rates per 1,000, for each of the forty-six weeks in the principal civil divisions of England and Wales.

It was of course impossible in the time available for the Registrar General to have had analytic studies prepared. Most of the conclusions regarding the initial areas affected by the several waves of the epidemic, the relative severity in populations of varying density and economic condition, the comparative damage done in each of the waves in the numerous registration districts, and other points of interest, were drawn from inspection of the crude results. It is hoped that students of the pathometry of influenza will avail themselves of the materials which the Registrar General has set before them and endeavor by approved methods of analysis to provide concise descriptions of the data.

The Ministry of Health of Great Britain has issued a comprehensive report on the influenza epidemic of 1918–1919.* Some of the chapters will be of interest to students of influenza pathometry. It is proposed to review these statistical chapters in a later number of the QUARTERLY.

E. W. KOPF

The Ownership and Valuation of Mineral Properties in the United Kingdom, by R. A. S. Redmayne and Gilbert Stone. London: Longmans, Green & Co. 1920. 256 pp.

One lays down Sir Richard Redmayne's latest book with the feeling that they do things better in England. He and his collaborator, Gilbert Stone, have brought together under a single cover the essential facts concerning property rights in minerals, methods of valuation for sale and taxation, and the present system of taxation in England, information which could be found in America, if at all, only after arduous search through many scattered sources. There is no book covering the American field like their *Ownership and Valuation of Mineral Properties in the United Kingdom*. The nearest approach to it consists of chapters on valuation in standard works on mining, such as those of Hoover, Finlay, and Young, and of papers by Chance, Brinsmade, Finlay, Allen, and others, scattered through the technical press and through the Proceedings of the American Institute of Mining and Metallurgical Engineers. The publications of the state and federal governments have dealt for the most part with specialized phases of the subject only, such as the valuation of iron mines or oil and gas wells for purposes of taxation, or the valuation of mineral-bearing public lands for sale or lease.

The authors are eminently qualified for the task they have undertaken. To it Redmayne brings not only ripe experience as colliery manager, consulting engineer, and professor of mining at the University of Birmingham, but also a record of years of public service as Chief Inspector of Mines for the United Kingdom, and as Assistant Fuel Controller during the war. Few men in England are entitled to speak with more authority on the mining industry than he. Mr. Stone's share in the work is apparently the portion relating to the law of mineral properties, and the combination of the viewpoint of the lawyer with the engineer is a happy one.

The book is designed primarily to assist the mining expert. It is, however, so clearly written as to be comprehensible to the layman, and it contains much descriptive matter of value to the student of economics. Partly because of the interests of its authors, partly because of the overwhelming importance of coal in the mineral industry of Great Britain, the book deals chiefly with coal properties, and its lessons for Americans are largely confined to coal.

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* *Report on the Pandemic of Influenza, 1918–1919.* London: H. M. Stationary Office. 1920. 577 pp.

Three chapters are devoted to the rights of owners and tenants, lessors and lessees, in mineral-bearing lands. Because of differences between English and American law with respect to property in land these are of limited interest to American engineers and economists. Of more immediate concern are the chapters on valuation for purposes of taxation and on the present régime of parochial and national taxes. The workings of the mineral rights duty, the excess mineral rights duty, and the increment value duties, as applied to coal lands, and also of the income tax as applied to colliery operations, are described. Taxation of coal-bearing lands is shown to be for the most part on the basis of royalties and rents, *i.e.*, on tonnage produced, not on the value of the coal in the ground. It is significant to note that four years before the war England had adopted a tax on the unearned increment in the value of mineral-bearing lands.

Two chapters on rents and royalties develop the fact that in few cases is the English coal operator at the same time the owner of the coal; instead he leases the coal bed and a wayleave to get access to it. The number of coal owners in the United Kingdom is stated to be about four thousand. Royalties differ from one field to another; a common form is shown to be a minimum fixed rental with provision for a royalty in addition of so much per ton on the coal produced above the amount necessary to make up the rental. The average royalty (pp. 72, 140) is thought by the authors to be five and one-half pence per ton, or translated into American units, about nine and one-half cents per net ton.

In the chapters dealing with valuation primary emphasis is laid on the valuation of holdings in coal lands rather than of producing collieries, though some attention is paid to the latter as well. American engineers will note with interest the constants for depreciation of plant and equipment, given on pages 123–4. Formulas are presented for the determination of present values, and much attention is given by the authors to the proper rate of interest to be assumed (a) to reimburse the investor for the risk of his original capital, and (b) to amortize the original investment by the creation of a sinking fund. The former the authors place at from 8 to 10 per cent on an ordinary mining risk, the latter at from 3 or 4 per cent in pre-war times, and from 5 to 6 per cent at present.

Throughout the book there runs a consciousness of impending changes in the coal-mining industry. As pertinent to the contemporary discussion of nationalization of coal mines the authors present an estimate of the value of the coal royalties in the United Kingdom, *i.e.*, the purchase price of the coal beds as distinct from the surface rights and from the investment in mining plant and equipment. This they place at approximately 70,000,000 pounds sterling, and they note that estimates of other values have ranged as high as 80,000,000 and 90,000,000 pounds sterling. The cost to the British Nation of expropriating the coal deposits of the country, allowing just compensation to the present owners, would thus be about the same as the annual naval estimates, which are reported as 82,000,000 pounds sterling net for the year 1921–22.

It is the assumption of the authors that in the event of nationalization of the coal deposits the state would continue to exact royalties from the operating companies (p. 86). "Only the consumer," they argue, "would gain by any reduction in royalties. . . . The ultimate result would be a reduced selling price and the stoppage of the inferior collieries unable to bring down their working costs to the required point." The authors have apparently fallen into an error shared by certain members of their respective professions in America. In the long run royalties are not an element in the price of coal to the consumer, but like the rent of land, are a differential between the return on marginal coal properties and more profitable ones. The price of coal in the United Kingdom is normally a competitive price, determined largely by the pull of the export demand upon the supply at home. In competing abroad with inferior foreign coals British producers have an advantage which they have been compelled to share with British coal owners in the form of royalties. In the absence of price fixation by the government the remission of royalties would swell the profits of the more favorably situated producers rather than lower the price to consumers.

F. G. Tryon

United States Geological Survey

The Movement of Wages in the Cotton Manufacturing Industry of New England Since 1860, by Stanley E. Howard. Boston: National Council of Cotton Manufacturers. 1920. 99 pp.

This report, published by the National Council of Cotton Manufacturers, again makes use of that increasingly popular device, the United States Bureau of Labor Index of Wholesale Commodity Prices, as a measure of the progressive increase of real as opposed to money wages for long-time comparisons. The extent of the rise of real wages in this case is so startling as to call into question the legitimacy of the use of that index as a measure of money wages in terms of cost of living.

Aside from a very interesting and competent digression into the inadequacies of the Fall River Experiment, which attempted to fix wages on the basis of a sliding scale based on the margin of profit, the report confines itself to the construction of a single index of wages in the Cotton Manufacturing Industry of New England since 1860. This is done to make possible a comparison of that index with the wholesale price index of the Bureau of Labor as a measure of the rise of real wages. The materials are taken from the reports of investigations of wages in the cotton industry made by the Weeks and Aldrich Investigating Commissions and by the United States Bureau of Labor. The construction of this wage index is a very careful piece of work. Supplementary historical and statistical data are included to throw as much light as possible on the causes of wage fluctuations owing to general business conditions, or to conditions peculiar to the industry, both technical and financial. Also, some attempt is made to show the degree and nature of unemployment and the extent to which all crafts within the industry were affected by wage changes, though such conclusions are necessarily rough because of the limitation of material.

The wage index shows that money wages in the industry in Massachusetts stood at 276.9 in 1915, as compared with 207.3 in 1911 before the Lawrence strike, and 100. in 1860. Because of the wide publicity of living conditions in Massachusetts cotton manufacturing centers at the time of the Lawrence strike, that point is as serviceable as any for making concrete comparisons with 1860. In 1911, when money wages stood at 207.3 in Massachusetts as compared with 100. in 1860, 6.61 per cent of the employees were receiving full-time weekly earnings, according to the report, of under five dollars; 50 per cent under eight dollars; and 90 per cent under twelve dollars. This does not take into account the relatively high degree of unemployment. That means that full-time weekly earnings, not counting unemployment, in 1860, would show 50 per cent of the employees receiving less than four dollars, and 90 per cent less than six dollars. These figures are well grounded as shown by the evidence presented. However, the report goes on to make a comparison of these money earnings with the cost of living, and uses the Bureau of Labor Wholesale Price Index as a measure of the cost of living. This shows that wholesale prices, and therefore presumably the cost of living, stood lower in 1911 than in 1860, 91.6 as compared to 100.

It is this discrepancy that challenges the validity of the use of the wholesale price index as a measure of real wages, especially over such long periods. It raises questions regarding the relation of wholesale to retail prices, and the relation of fluctuations of business prices to prices entering into the cost of living, especially for periods as distant as 1860. To what degree did the cost of living enter into the business system? To what extent were rents reflected in the wholesale price index in 1860? What was the effect on food prices of the less-crowded living conditions, making garden cultivation possible? To what extent was the town fed by the immediate countryside, excluding large-scale speculation in foods, and the transportation and wholesale handling of them?

These and similar questions must be answered before any such conclusions as appear in this report can obtain critical acceptance. Such comparisons are always interesting. Their danger lies in their uncritical employment by those to whom the publishers may distribute this report.

Winfield W. Riefler

Amherst College

A Study of Women Delinquents in New York State, by Mabel Ruth Fernald, Mary Holmes Stevens Hayes, Almena Dawley, and Beardsley Ruml. New York: The Century Company. 1920. xviii, 542 pp.

This study of women delinquents in New York State, to which Katherine Bement Davis has contributed the preface, is illustrative of the kind of investigation that ought to be carried on in all the prisons of the United States. For centuries we have been trying to reduce the volume of crimes by crude and unscientific methods, making little or no attempt to understand the human beings whom we hanged, tortured, and imprisoned. Why the criminals themselves have been so long overlooked and neglected, and their acts given so much attention by lawmakers will be one of the questions for future historians of civilization to wrangle over.

The book is based on the case histories of women found in certain institutions, together with the histories of a group of women placed on probation by the Night Court of the boroughs of Manhattan and Bronx. Although these institutions represent all the types of institutions in which women are confined in New York State, not enough attention was paid, in the reviewer's opinion, to their location. Some should have been selected that served the needs of purely rural communities in order that all types of delinquent women might be included in the picture. A more serious criticism could be made of the number investigated. Only 587 women were covered by the survey. When this total is divided into various groups, the number in each group is rather small for statistical purposes. One must remember, however, that it is no easy task to obtain data such as has been collected for this group of women, and should be thankful that the number is as large as it is.

While including the data ordinarily presented in statistical studies of delinquents, such as sex, age, marital condition, color, and nature of offense, the investigation deals also with early home conditions, educational background, occupational history, sex irregularities, and mental capacity—matters of far more significance to the seeker for causes of criminality. The difficulty that is met with in leaving the well-beaten statistical paths lies in the fact that there is no corresponding data for the population of the country as a whole with which to make comparisons. The authors fully recognize this fact and warn the reader constantly against drawing wrong conclusions. One feels, nevertheless, that some very interesting side lights have been thrown on the problem of crime. For instance:

A very large percentage of the women came from poor homes and a still larger percentage from homes in which there was poor parental supervision.

There was a very slight relationship between education and the various aspects of delinquency.

Over half of the women were idle at the time of conviction.

Delinquency and defective intelligence are *not* synonymous.

There was no demonstrable difference between the mental capacity of recidivists and of first offenders.

There was no demonstrable difference in mental capacity between those who use drugs and alcohol and those who do not.

There are indications that environmental factors have more to do with conduct than Goring supposed.

Probably it would have been better to have omitted some of the calculations, as, for example, tables 164 and 223, as the data does not warrant use. Aside from this tendency to push the investigation further than the facts warrant, the work merits high praise for its painstaking quality, and other investigators will find it well worth studying before they try their hand at similar tasks.

Louis N. Robinson

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QUARTERLY PUBLICATION OF THE

AMERICAN STATISTICAL ASSOCIATION

THE BETTER USE OF VITAL STATISTICS IN PUBLIC HEALTH ADMINISTRATION*

By Arthur Newsholme

Since I promised to speak on the subject announced, its apparent inappropriateness to a post-prandial assembly has obtruded itself more clearly on my mind, and I must in actual fact confine myself to a desultory discussion of some elementary considerations which bear on success in the administrative use of vital statistics.

Some years ago you honored me by electing me an honorary member of your Association, and since then I have received regularly your Quarterly Publications. Their perusal furnishes ample evidence both of the great advance made in this country in statistical study, and of the increased scope and accuracy of your records; and there is evidence of this same advance in the statistical publications issuing from Washington and in many of the reports of state and city health commissioners.

It appears to me to be desirable, in the first instance, to define the position of vital statistics or biometrics in public health teaching and administration. They occupy an essentially subsidiary position, being one of several tools which the public health worker employs in his pursuit of knowledge and measurement of results. To place them on an equal footing with the fundamental sciences of biology, chemistry, and physics, and of pathology, preventive medicine, and epidemiology in public health administration or in an organized program for the training of public health officers appears to me to imply confusion of thought and of plans.

In their present stage of development in most communities, vital statistics form an excellent servant but a very bad master for the health officer. They have been invaluable in stimulating and in guiding past public health effort, and especially in directing attention to the areas of excessive general mortality, and of excessive mortality in infancy and from special definite causes of mortality; but medical certification, especially with regard to the more general and so-called constitutional diseases, is still defective, and conclusions based on municipal or national statistics dealing with this certification must be held in suspicion. Even under more definite headings we need to bear in mind the necessary limitations of statistical inference.

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* An address delivered at a dinner meeting of the American Statistical Association in New York City on April 15, 1921, in honor of Sir Arthur Newsholme, M.D., K.C.B., on the eve of his departure for England.

Mass statistics give information which is inferior in value to the information derived from the intensive investigation of individual cases — the dynamic method of study. As James Clerk Maxwell said, "however imperfect the dynamic study of man may be in practice, it evidently is the only perfect method in principle," its shortcomings arising not from a faulty method of procedure, but from the limitations of our powers. On the other hand, results obtained by the statistical method "belong to a different department from the domain of exact science."

Many inductions in causation and in the preventive or clinical treatment of disease cannot, with our present knowledge, be expressed otherwise than qualitatively, and yet they are as well established as if they could be stated quantitatively. This is especially true for inductions as to the results of some forms of sanitary and social effort. Two instances may be adduced.

It is often difficult to show any quantitative relation between the amount of sanitary and social effort, and the reduction in the death-rate from tuberculosis. This relation evidently must be one between the total prevalence of the disease and opportunities for its communication on the one hand, and the totality of measures taken or operating for its prevention on the other hand. Were it possible to measure and to weigh exactly the value and the extent of action of each factor concerned, the relation could be shown; but we do not possess adequate knowledge for this purpose. We know, for instance, that the conditions of urban life conduce to increased tuberculosis. We know also that the death-rate from tuberculosis has declined to a greater extent in cities than in country districts. Were we able to state quantitatively the influence and the extent of action of, say, overcrowding, indoor and dusty occupations, dirty habits, etc., in increasing tuberculosis, and of improvements in domestic cleanliness in habits and homes, in greater segregation of the sick, in better factory hygiene, and in higher nutrition in diminishing tuberculosis, we could measure the relative share of each of these factors in the given result in any community. Failing this, as public administrators we possess the wider outlook of physicians and of students of social phenomena, and we are satisfied that the precise teaching of pathology, the exact scientific experience in Denmark and in this country in the elimination of tuberculosis from herds of cattle, the analogous experience with leprosy, and the facts which we possess, confirming our pathological knowledge and showing historical relation between hospitalization of tuberculous patients in different communities and reduction in the tuberculosis death-rate, all point to the conclusion that to diminish infection from open cases of tuberculosis, and especially to diminish this for infants and for children in the first five years of life, historically has been and administratively now forms the chief means for reducing the mischief done by this great enemy of mankind.

A similar difficulty arises in measuring the value of the medical and hygienic work of health centers and of public health nurses in reducing infant mortality. Did we possess quantitative knowledge of the value of each factor influencing infantile health and disease, and were we able to measure the extent of action of each factor, it would be possible to assess the relative importance of each factor concerned in producing or preventing infantile sickness and mortality. But we usually cannot do this. It is not difficult to show curves of infant mortality for different cities, almost exactly parallel in a long series of years, in some of which health centers and public health nurses have been actively at work, while in others their number has been few or there has been none. Furthermore, such curves are not unnaturally flourished before us by economists, as well as by biometricians, as prima facie evidence of the inutility of the educational and medical work of physicians and nurses in child welfare work. But these confident assertions leave us quite cold! Were all the gross mass figures which could be marshalled to point to the conclusion that ignorance is no worse than knowledge, and that domestic cleanliness is not worth while, we should very properly doubt their accuracy or their teaching, not the merits of sanitary education and practice. In actual fact we can by comparison of carefully selected areas in different towns show the value of sanitation and instruction in reducing infant mortality, although—inasmuch as with these two factors other factors are also concerned for which accurate information cannot be tabulated—we are in most instances up against the impossibility of measuring satisfactorily the value of each single factor. In short, in a large part of public health work we must content ourselves with the fact that our work is on the lines which our knowledge of physiology, pathology, and medicine—the institutes of medicine—shows to be important, and reserve to the future the possibility of securing non-fallacious measurements of complex social influences.

Although the examples just cited display my unwillingness to submit to the sole arbitrament of arithmetical standards in the measurement of results of public health work, when pathology and medicine give accurate guidance, I would not convey the impression that vital statistics fail to give most valuable guidance in public health work; they are, indeed, indispensable for such work.

I have always regarded vital statistics as a means to an end, and not an end in itself; and my own first acquaintance with the subject arose out of the need to study these statistics, to which in the third quarter of the last century there was no English guide extant. The publication of my *Elements of Vital Statistics* led to personal contact and correspondence with medical statisticians in many countries—a relationship which became more extensive and more valuable as epidemiological investigations on successive subjects formed my fascinating task.

I recall, for instance, investigations which I undertook into pandemics of rheumatic fever and of diphtheria, in the first of which scarcely any records from America were available; but in diphtheria there was ample evidence from this country showing the natural tendency of diphtheria to be more extensively continental than insular in its incidence, and for its endemic prevalence to be on such a scale as to disguise partially the epidemic characteristics of the disease.

At a later period I recall an international inquiry in which Dr. Stevenson, now the distinguished medical statistician of the English Government, and I were engaged, in which it was desired to obtain corrected birth-rates for different cities, making arithmetical allowance for the proportion of married women in the population and for their age. And it will not be surprising to some of you to learn that the most valuable records available in America were those compiled by Dr. C. V. Chapin for the city of Providence, Rhode Island, records which with similar records from Boston showed that the American born in these cities had reached a position as regards fertility almost as low as that of Paris.

During the last ten years the value and scope of American vital statistics have greatly increased; and in addition to the important publications of the federal and state governments, your literature has been enriched and the borders of knowledge extended by the publications of many workers, including Dr. Hoffman, of the Prudential Insurance Company, and Dr. Louis Dublin, of the Metropolitan Life Insurance Company. To both of these gentlemen I have been indebted for valuable references and information during the last two winters while teaching in the Johns Hopkins University.

Your death-registration area and your birth-registration area have become extended, and the accuracy and completeness of registration have increased, though it is evident that much more needs to be done; and it remains an anomalous fact that in a community which prides itself, and rightly, on its business capacity, and which makes almost a religion of efficiency methods, there is a serious lack of driving power to secure from every community throughout the states the accurate data of births, sickness, and deaths without which periodic vital stock-taking is impracticable. In England Benjamin Ward Richardson could say many years ago in referring to Farr's epoch-making reports that it is "no longer true that pestilence walketh in the dark. It is measured and registered, walketh at last in the open day."

This is becoming more nearly true for the United States, though in many areas there is still inaccurate certification of deaths and classification of the returns in statistical offices is still unskilled; the records of sickness also are imperfect.

A few years ago in many states the registration of births was so incomplete that it was impossible to determine whether any apparent decrease in the rate of infant mortality was real or was due in part or entirely to "drives" which had been followed by improved registration of births! This happily is being improved, but the margin of error in many areas is still a serious handicap in statistical inquiries.

Among the difficulties in the way of an accurate national system of registration of births and deaths in America may be named the following:

1. America is the subject of the vastest experiment in the world's history in mixture of races. Not only has it a large negro population and a not inconsiderable population of the red and yellow races, but Anglo-Saxons, Germans, French, Slavs, Italians, Jews, and other peoples are adding to its population year by year; and although the Anglo-Saxons still predominate, this preponderance will cease ere long unless relative race-birth-rates greatly change, and the largest element on this continent will be no longer Anglo-Saxon. Happily, the American population of the future will still possess the glorious heritage of law and language, of freedom and self-government, and of moral ideals, with which the name of Anglo-Saxon is rightly associated.

With such a conglomerate and mobile population, with problems of digestion and assimilation of foreign elements on an enormous scale, it is not surprising that registration of births and deaths, with its possibilities of measuring the relative vitality and social progress of different social elements, has been neglected. It is none the less a misfortune for humanity that accurate and complete records have not been kept of the greatest social and sanitary experiment in the world's history.

2. The state sovereignty of each of the forty-eight states has been inimical to the compilation of accurate comparable national statistics. The Bureau of Vital Statistics in the Department of Commerce of the federal government publishes annual reports which year by year are increasing in value; but water cannot spontaneously rise above its own level, and these reports have no higher value than that of the records of each individual state. Although the international rules as to classification of deaths are well known, what certainty have we that in the majority of these states these rules are rightly followed in the allocation of deaths to their appropriate heading? It would probably be impracticable for the federal government, in view of the magnitude of the task and the separate sovereignty of each state, to arrange for a federal as well as a state analysis of every single death in the country, thus ensuring exactly comparable data. This has been done in England, thus giving an accurate check on the locally published vital statistics for every sanitary area throughout the country, and rendering these statistics of local mortality comparable with those for all other areas.

3. In the majority of states the lack of civil service conditions of appointment and tenure of office of the statistical superintendent has, I gather, meant much inefficient work. This is preëminently an appointment in which evidence of competence for the post should be demanded. The majority of state statisticians in the past have been untrained physicians, with no special interest in the compilation of accurate statistics; they were not concerned with enforcing the law of registration, and were ignorant of the principles of death certification and classification.

In the General Register Office in London there is a medical statistician, a worthy successor of Dr. Farr, who has associated with him a staff competent to undertake all the needed tabular work, and who can call in the services of actuarial consultants when required. This secures a due performance of the work of registration, tabulation of results, and commentary on the classified results. The knowledge of a fully trained scientific physician, and an adequate training in the principles of death certification and of the classification of diseases, are indispensable in collecting and in utilizing vital statistics; and many well-intentioned investigations by biometricians, so-called, have shown what ridiculous results may be published in the absence of accurate pathological and medical knowledge. Complexes are treated as individual entities; "constitutional diseases" occupy the stage, although this term has ceased to have a definite and exact meaning in modern pathology.

Similarly, "heart diseases" and "renal diseases" are used in comparisons, as though each of these complexes had a single and simple, instead of a multifarious, causation. The constitutional factors and the organic fitness of the population are the subject of pseudo-learned disquisition, in happy ignorance of the elementary facts that the majority of so-called constitutional diseases—possibly all—are due to poisoning or infections derived *ab extra*, and that cardiac and arterial diseases, for instance, owe their origin chiefly to infections, of which syphilis and rheumatic fever are far and away the most important.

Incidentally, although we may properly attach importance to the hygiene of middle life and to periodical medical examinations as means to aid in preventing, or in securing the early treatment of, illness, it is well to bear in mind that the prevention of breakdown in early and late middle life is much more wrapped up with the prevention of the infections of childhood, of adolescence, and of early adult life than with any other factor that can be named. In substantiation of this statement I need only mention tuberculosis and syphilis, which together probably are responsible for one out of every five deaths from all causes at all ages in the aggregate.

4. It is unfortunate that in some states, including, I believe, Massachusetts, Ohio, and Michigan, the registration of births and deaths is not in charge of the Public Health Department of the state; and that ready access of each health officer to the vital statistics of his area may thus be a matter of grace not of right, sometimes of belated grace.

5. As far as I can ascertain, it has not been found practicable to relegate institutional deaths to the vital statistics of the place of usual residence of the deceased. In England Dr. Stevenson and I were able to organize a successful system by virtue of which the General Register Office in London has become a clearing house, and all deaths of nonresidents, institutional as well as others, are referred to the area in which the deceased lived. Prior to this, curious errors occurred. An area in which a large maternity institution existed had a terrible infant mortality; and a city which prided itself on its low tuberculosis death-rate and ascribed this low mortality to its dispensary machinery, had its tuberculosis hospital for advanced cases outside the city boundary! To what extent such blunders occur in America, I cannot say. Its dimensions and population are probably too vast to admit of a federal system of relegation of deaths of outsiders; but it might be done for each state. In passing I would deprecate the imperfect correction for deaths of visitors which was commonly practiced in England prior to the institution of the system I have indicated. Health officers very

willingly excluded institutional deaths of visitors, but were less willing to add outside deaths belonging to their area!

6. In sickness registration I had the privilege of initiating one of the most valuable reforms in England, viz., the weekly tabulation in the offices of the Local Government Board (now the Ministry of Health) of the number of cases of each of the notifiable infectious diseases in every one of the 1,800 sanitary areas in England and Wales, and their publication and distribution within three or four days to every health officer. For some fourteen years these have now been summarized in an annual return, thus presenting one of the most valuable epidemiological mines of information extant. The weekly returns of cases circulated from Washington by the Public Health Service are a step toward securing similar statistics in this country; and in this connection should be mentioned the valuable relation established between the federal and state health services by the appointment of officers of the latter as collaborating epidemiologists.

7. A striking lack in the vital statistics of the United States is with respect to housing accommodation. The decennial census returns in England enable health officers to ascertain for all cities and larger areas the number of inhabited houses in each ward, the number of families living in one, two, three, four or more rooms, the number of rooms in each of these groups in which there are on an average more than two persons per room, and whether the overcrowding is of children or of adults. This information has important social significance.

8. I do not propose to discuss the difficulties which must obviously arise federally from having the responsibility for vital statistics divided between several federal departments; nor those which arise from the county control of collection of statistics in some states. I merely state the general proposition in which all familiar with the importance of the subject and the fundamental need for uniformity of method in securing data and in classifying the data when obtained will agree, that *centralized administration on a large scale is essential if accurate and strictly comparable statistics are to be obtained.*

It is equally necessary that every health officer of every state, of every county, and of every city or smaller community should receive at least weekly full particulars of every birth and death occurring within his area, and should receive daily notifications of every case of infectious disease occurring within his area.

The preceding very imperfect review of the situation may be supplemented by some further suggestions—obvious, but none the less important—for making the statistics of each state and of every area within the state increasingly useful in the service of the community. Vital statistics are merely a means to an end. Their value consists in the light which they can throw on the prevalence of disease and on the means for diminishing its incidence.

I have not seen a state public health report in which the possibilities of utility of vital statistics have been fulfilled, although many such reports approach this goal, and still more contain much valuable material. It is necessary to bear in mind, however, that a heap of bricks does not constitute a house; and that undigested statistical matter should preferably be filed in the statistical bureau for further reference and treatment, and not presented in expensive and repellent tables to a public which is quite properly unsympathetic to such matter.

There is need for detailed study of the vital statistics of every city and state by men who have adequate medical knowledge, who can avoid the elementary pitfalls of statistics, and who above all are enthusiastically obsessed with the public health possibilities in the careful study of local statistics. In statistical work there has been, hitherto, too much shovelling into heaps, and too little building of the edifice of public health. No elaborate mathematical work is needed for the study which I am advocating, or for ordinary public health needs; but it is necessary that there be an observance of the well-known rules of statistical accuracy and of sound reasoning, based on scientifically established pathological and medical knowledge, and made with an enthusiastic desire to *make statistics act as a pointer* to the areas in which excessive mortality or sickness exists, in order that—an intensive study of its vital statistics having been secured—a corresponding social and sanitary investigation may follow and the appropriate remedy may be applied.

Such intensive studies are of special immediate importance in relation to the *mortality of maternity*, *infant mortality*, and *mortality from tuberculosis*. I am assuming that the sanitary index formed by typhoid fever and the important index of domestic cleanliness which the prevalence of infantile diarrhoea supplies, are kept constantly under supervision.

Together with these two, there are no more important indices of the welfare of a community than the three named above; and it ought to be practicable to state, year by year, for every area and every subdivision of an area, *e. g.*, each ward of a city, the mortality associated with child-bearing, the total and the neo-natal infant mortality (*i. e.*, under one year old and under one month old) in terms of births, and to take public health action in accordance with the findings. Hence the essential importance of complete birth registration. And it is not reassuring to find that in the year 1916 in the New England states there were revealed the following degrees of defective birth registration. There were no birth certificates in the case of 15.2 per cent in Connecticut, 9.5 per cent in Maine, 8.7 per cent in Massachusetts, 5.6 per cent in New Hampshire, 18.3 per cent in Rhode Island, and 5.7 per cent in Vermont, of the infants who died under the age of one year. Allowing for migration of infants from without each state, which must be small in amount, these figures cannot be regarded as satisfactory.

How much more effective would be the work of our public health nurses and at our health centers if the work were concentrated particularly on the infants in areas in which intensive statistical studies show that infant mortality is heaviest; and how much better directed and therefore more successful would be that work in the diminution of neo-natal mortality if every health officer had it forced on his attention that in some parts of his area the loss of life in the first month of extra-uterine life may be twice as heavy as in other parts; and if instead of futile observations as to the relative importance of "congenital debility," "prematurity," "marasmus," or the like in the death returns—which are mere labels of inexactitude of knowledge—and instead of the theoretical and generally unfounded assumption that deaths occurring at this tender age are unavoidable, assistance were given which would secure adequate care of the mother in pregnancy, in parturition, and during the critical first month after birth. It may of course be argued that unless we know the causes of this early infant mortality we cannot act intelligently against it. Such a statement illustrates well the difference between the arm-chair statistician and the competent physician engaged in public health work. The latter knows, for instance, that syphilis is responsible for a large share of this early infantile mortality, although it but seldom emerges in death certificates, and that its maleficent action on foetal tissues can be prevented. He knows, again, that many of the fatal conditions, which cannot as yet be expressed in exact pathological terms, do not arise when appropriate medical, nursing, and domestic assistance are provided for the expectant, parturient, and nursing mother. The statistical differences in neo-natal mortality, and it may be added in the number of still-births in different areas amply confirm this conclusion.

The definition of still-births adopted in different states varies, and apart from this there are large differences in the extent to which such births are registered; and to propose, as has been done, to state puerperal mortality in terms of total including still-births, instead of in terms of live-births, is to depart from the nearest approach to an accurate denominator for the rate hitherto available.

In conclusion let me—while expressing my appreciation of the essential role of vital statistics as an instrument in extending our knowledge of the epidemiology and social history of each disease (its social history is really a part of its epidemiology), in estimating the relative position of different communities, and in assessing the value of sanitary and social work—deprecate the statistical use of groups of diseases, of multiform and heterogeneous origin, for comparative purposes as being just as unscientific as it would be for the biometrician or the chemist to insist or even to permit himself to study the properties of hydrogen in the contents of a jar containing a mixture of this gas with half a dozen other gaseous elements.

I further press the point that vital statistics can have no higher value than that of the individual death certificates on which they are based; that no conjuring with classifications will render indefinite and dubious data other than they are; and that the only line of safety in most instances is to study each certified cause of death independently and separately.

I would, finally, emphasize the important consideration that when statistics having only a qualitative and compound value are being studied, and when the factors concerned cannot—as is so often the case—be analyzed quantitatively, we are justified in denying, indeed it is our duty to deny, the value of "biometrical" work based on such data, and in resting our inferences and our administrative action, as guardians of the public health, on a careful balance of all available evidence, giving chief place to exact physiological and pathological evidence bearing on our problem.

CERTAIN PROPERTIES OF INDEX NUMBERS*

By Truman L. Kelley, *Stanford University*

Acting upon the assumption that the significance, limitations, and general meaning of an index number lie within the grasp of a non-economist, the present writer has dared to enter the field, already so ably investigated by economists, with the present statistical contribution. The two ideas that he brings to this study, which have been but partially noted in the references given at the close of the article, are, first, the importance of knowing the probable error of index numbers and the method of their calculation; and, second, the significance of correlation between price ratios in the building up of an index and in the entry and withdrawal of items.

The price of a commodity in some one year, p^1_1 (the superscript designates the commodity, while the subscript designates the year), divided by the price of the same commodity in a second year, p^1_2, is p^1_1/p^1_2, and is called a price ratio. A composite of several such ratios purporting to portray a general relationship between prices in the two years is a price index, P_1/P_2. The fundamental concept in this is the ratio or geometric concept. Indices can be built upon many bases, but irrespective of the method of construction, the usual interpretation will involve this geometric concept. The lay reader will think that P_1 is a certain proportion of P_2, and P_2 is the inverse proportion of P_1. An index which is not reversible does not parallel the thought processes inherent in the concept "price ratio," and this more elementary concept, where reversibility is the rule, is the one by means of which "price index" is interpreted. Even writers who are quite aware that the index they are using is not reversible, use price ratios and price indices in such a way that it is obvious they expect the same sort of concept to be called up in the reader's mind; for example, "$p^1_1/p^1_2 = 122$, but $P_1/P_2 = 120$ so that, etc."

In as far as the concept P_1/P_2 is commonly of a different nature from p^1_1/p^1_2, it lies in the fact that P_1 and P_2 are averages, and p^1_1 and p^1_2 are single measures. Accordingly, to parallel customary thinking, P_1/P_2 should mean a reversible proportion between averages. What an "average" is may not be so definitely established in the minds of scientific people generally as is the idea "ratio," but probably the most common concept is that of arithmetic average or mean. We therefore have the somewhat anomolous situation of P_1/P_2 calling up the arithmetic concept when dealing with the two separate elements involved in it, but the geometric concept when dealing with the thing entire. Since this mixture of concepts seems likely to persist, the writer proposes as an important test of the excellence of an index number the closeness with which the operations involved in it parallel general thinking tendencies: *First and most important, reversibility of ratio, and second, arithmetic averages involved in the parts.*

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* The article herewith presented, except for certain footnotes and a few minor changes, was written before the appearance of the March, 1921, number of the Quarterly containing the abstract of Professor Fisher's Atlantic City paper. This paper and the attendant discussion have suggested certain things which might well have been included, but they have not indicated a withdrawal of any portion of the present paper. It therefore seems more convincing, as an independent contribution, to let the article stand as originally prepared than to rewrite it with a view to bearing upon the detailed questions raised by Professor Fisher.

That a price index has a probable error is a fact not always recognized and not entirely obvious, for it may easily happen that the price ratios are entirely reliable. It may be possible to say that the price of cotton at a certain time was $p^1{}_1$ and at a second time $p^1{}_2$. If the price quotations are accurate, then the price ratio $p^1{}_1/p^1{}_2$ is a true measure. The average of several such gives P_1/P_2, which is invariable. Therefore, P_1/P_2 has zero probable error as far as being the average of these particular things, but the very combining of them involves the assumption that the index has significance beyond the particular data from which it is calculated. The only exception would be when P_1 and P_2 are determined from all the possible data. As an example, let $p^1{}_1$ be the price of coal at a certain mine at the first date, $p^2{}_1$ the price at a second mine, . . . , $p^n{}_1$ the price at the last mine, and similarly for the p_2's. Then, since all the sources are involved, P_1/P_2 is the index of coal prices and has no probable error, except such as might be due to faulty quotations and calculations and could therefore, by proper care, be made negligible.

This is not the typical situation. Ordinarily but a few quotations are worked up into an index and the result taken as representative of an industry or a field. We therefore have quotations which are samplings of the prices in the industry, and the statistical methods for determining the reliability of samplings apply. The formulae for probable errors given later in this article are based upon certain assumptions, including that of random sampling, but if 25 or more per cent of the possible quotations are utilized, material error in the formulae is introduced, the true probable errors being less than those given by the formulae. It is to be understood that by probable error in an index number is meant that which arises from incompleteness of data. In the following determinations of probable errors of index numbers as given by various formulae, the attempt is to see how closely one can approximate, by a sample, the number which would be obtained were all the possible data utilized in determining the same sort of index. The probable error indicates how closely the results from the sample may be expected to tally with the results from the whole. Should there be a constant tendency in the form of index used, systematically leading to too high or too low a value, we have a systematic error, which is entirely distinct and which is not measured by the size of the probable error.*

The reason why a few quotations can yield an index which is a close approximation to a general tendency is that there is a high correlation between the quotations included and those not included in the index but pertinent to the function being measured. If there are two hundred coal mines and quotations from a half dozen are taken, an index in close agreement with the true index based upon the two hundred may be expected, because of the high correlation between quotations at different mines. To say that there is a high correlation is not equivalent to saying that the prices at the different mines tend to approach the same level, but that they tend to maintain a uniform difference. Mine A, near tidewater, may sell at a certain price, p^1, much higher than that, p^2, at mine B, remote from a center of consumption, without indicating an economically abnormal condition in the coal trade. If p^1, p^2, and other similar measures are averaged, the probable error of this average is not given by the usual formula

$$\text{P. E.}_{\text{mean}} = .6745 \frac{\sigma}{\sqrt{N}}$$

due to the heterogeneity of, and to the correlation between, the p's. As an illustration, more extreme than mine quotations on coal, let us average the following prices:

Bacon per pound	$.70
Bread per pound	.10
Potatoes per bushel	1.20
Apples per box	10.00
Average	$3.00
Standard deviation	4.06
P. E. (by above formula)	1.37

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* In the tests of indices suggested later in the paper there will be found none to the effect that an index should have no bias. The reason for this is that reversibility of ratio, or change of base, which is included as one of the tests, is not possible with a "biased" index. Fisher (1921) shows that an index may possess a bias due to form and a second bias due to base value weighting, and that these may exactly neutralize each other. Such a situation would, statistically, be the same as one not involving bias.

Now, presumably, the probable error of no single one of these quotations is as great as $1.37, and the average of them all will probably fluctuate but little. There probably is positive correlation between these food prices, a rise in one generally going with a rise in each of the others. These conditions are not those under which the probable error of an average is given by the usual formula. For statistical purposes there is much to be gained by having homogeneous uncorrelated material. We can secure measures which are nearly, if not entirely, homogeneous and uncorrelated by dealing with price ratios instead of prices.*

Accordingly, if the price index showing prices in year 1 relative to year 2, called i_{12}, is given by the equation,

$$i_{12}=\frac{P_1}{P_2}=\frac{1}{N}\Sigma\frac{p_1}{p_2} \quad \text{(Index formula 1)}$$

and if the standard deviation of the price ratios is σ_{12}, the probable error of i_{12} is given by

$$P.\ E.\ i_{12}=.6745\frac{\sigma_{12}}{\sqrt{N}}. \quad \text{(Probable error of index formula 1)}$$

Let us consider another kind of index,

$$i_{12}=\frac{P_1}{P_2}=\frac{\Sigma p_1}{\Sigma p_2}. \quad \text{(Index formula 2)}$$

The complete probable error formula for this kind of index involves the correlation between the p's. (See Pearson, 1910.) The index,

$$i_{12}=\frac{1}{\Sigma_w}\Sigma\left(\frac{p_1}{p_2}\right)w \quad \text{(Index formula 3)}$$

will be more reliable than formula 1 if the weights, w, used are exactly or approximately proportionate to the values of the commodities involved. In general, the greater the price ratio the less the consumption and vice versa, so that the distribution of the weighted price ratios will have a smaller variability than the distribution of price ratios alone. If $w=p_2q_2$, the value of the transactions in year 2, the formula becomes

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* In one sense, both prices and price ratios are very highly correlated, but these correlations have quite different statistical consequences. As the price of coal at mine A approaches p^1_1, due to correlation the price at mine B approaches what may be a very different value, p^2_1; but as the ratio, p^1_1/p^1_2, from the quotations of mine A approaches, as time changes, the value ρ, due to correlation, the ratio of the quotations from mine B may be expected to tend toward the same value ρ. (The rigorous proof of this statement would be necessary before the present treatment and statement of probable errors can be considered final. Whatever error is involved is of a conservative nature, as it almost certainly would tend to make the obtained probable errors too large.) Although correlation between prices tends to throw ratios together, it tends to keep prices apart. If, therefore, we deal with ratios, the effect of correlation has already operated upon the measures used, making the distribution of ratios more homogeneous, and as a consequence making the mean more reliable. In other words, the standard deviation of the ratios of prices at date 1 to those at date 2, σ_{12}, is reduced from what it would be were there no correlation between prices, so that by this very reduction, the probable error formula when applied to ratios takes account of the correlation between prices at two different dates. For a rigorous approach to the question of probable error of a ratio see Pearson (1910 and 1911).

$$i_{12}=\frac{\Sigma p_1q_2}{\Sigma p_2q_2}. \quad \text{(Index formula 4)}$$

Formula 4 is but a type of formula 3. It is undoubtedly more reliable than either 1 or 2, but there are too many variables involved for the writer to attempt a calculation of its probable error based upon the data for two dates only. If, however, the commodities are divided into random halves and indices determined from each half, the correlation between these sub-indices may be calculated, and from it the probable error of the total index may be obtained, as follows:

Let there be n commodities, equally excellent as representative of the whole field, which are built up into the index i. In order to determine the probable error of i we may first build up two indices, A and B, each based upon a random half of the commodities. Calculation of A and B for a number of dates will give two series, the correlation between which may be found. In doing this it is desirable that the time interval between successive indices be sufficient to insure the relative independence of the commodity quotations involved. Just as the average of the prices of bread on January 1 of a certain year and on December 30 of the same year will in general give a truer average yearly price than the average of the prices on June 30 and July 1, because in the former case the two quotations are nearly independent while in the latter one has practically but a single quotation, so sub-indices calculated at too short intervals of time scarcely constitute new data, but rather repetitions of old data. Were the correlation between successive quotations known, practical limits could be set giving periods shorter than which it would not be worth while to calculate sub-indices. Having r, the Pearson product-moment coefficient of correlation, between these sub-indices, ordinarily called the reliability coefficient, we may infer the reliability coefficient, R, of the entire index, i. This is a measure of the extent to which the index i would be expected to correlate with a second similarly derived index, and is given by the formula (Brown, p. 102, 1911),

$$R=\frac{2r}{1+r}. \quad \text{(Formula to infer the reliability of a measure knowing the reliability of its halves)}$$

The probable error of i is then given by*

$$P.\,E._{\cdot i}=.6745\,\sigma'\sqrt{1-R}$$

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* The correlation between the index i and the "true" index, where the true index is defined as the average of a very large number (an infinite number) of such indices as i, is $\sqrt{R}$. (For proof see Kelley, 1916.) Now consider a correlation table, or scatter diagram, between true index values and i-values. The standard deviation of the arrays corresponding to a certain true score, according to the usual

in which σ' is the standard deviation of the indices i for the same period of time as covered by the correlation table giving r. If σ equals the average of the standard deviations of the two series of sub-indices (presumably these two standard deviations are very nearly equal) then*

$$\sigma' = \sigma\sqrt{\frac{1+r}{2}}.$$

Substituting the values found for R and σ', the probable error formula may be rewritten,

$$P.\ E._{i} = .6745\ \sigma\sqrt{\frac{1-r}{2}}.$$ (Probable error of an index in terms of the correlation and standard deviation of sub-indices)

Note that r and σ must be obtained from the same series of sub-indices.

The practical advantages of reporting two sub-indices as well as the total index may well be as great as has been found to be the case in reporting two comparable measures in the fields of psychology and education. The probable error of any index may be determined if comparable sub-indices are calculated and if the series of indices covers a sufficient length of time to yield a reliable measure of correlation between sub-indices. Probably 16 pairs of quarterly sub-indices would suffice.

Accordingly, a second important measure of the excellence of an index number is *the size of its probable error.*†

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formula for the standard deviation of an array (see Yule, 1912) is, $\sigma i.t = \sigma'\sqrt{1-(\sqrt{R})^2}$, in which σ' is as defined above and $\sigma i.t$ is the standard deviation of the i's for a given true value of the index. Thus $\sigma i.t$ is simply the standard error of the index i, and the probable error is .6745 times as great.

[*] Let σ_1 = the standard deviation of the A series of indices, σ_2 of the B series, and let $i = (A+B)/2$. Let Δ stand for a deviation (an error as judged by the true index) in the i index, δ for one in the A index, and d for one in the B index, then,

$$2\,i = A+B$$
$$2\,\Delta = \delta + d$$

Squaring, summing, dividing by N, the number of cases, and noting that the sum of the δd products equals $Nr\sigma_1\sigma_2$, yields,

$$4(\sigma')^2 = \sigma^2_1 + \sigma^2_2 + 2r\sigma_1\sigma_2.$$

If the standard deviations in the right-hand member are nearly equal we may replace them by $\sigma[=(\sigma_1+\sigma_2)/2]$ giving,

$$\sigma' = \sigma\sqrt{\frac{1+r}{2}}.$$

[†] I judge from the none too complete abstract that Fisher (1921) has calculated a large number of different indices from the same material and found that certain formulae give highly comparable results. The uniformity of indices involving the same data is not the problem of reliability here attacked. We are concerned with the problem of sampling. As to whether Professor Fisher has also compared an index determined from a part of his data with the same index as obtained from a larger part I cannot determine from the abstract, but if so it constitutes an experimental approach to the problem in hand. One would expect that the differences which Professor Fisher would find between an index based upon, let us say, ¼ of his data and one based upon the remaining ¾ would be somewhat larger than implied by the formulae here given, as the index based upon the ¾ would be a fallible standard. A study of the uniformity of indices based upon the same data throws light upon the existence and the nature of systematic tendencies, or biases, but none whatever upon the error of sampling.

Space will not permit a discussion of the probable errors of all the proposed types of indices, but to point out the necessity of such discussions the writer has made an estimate, after more or less complete mathematical analysis, of the relative size of the probable errors of the index numbers given in the table on pages 836–7.

The one that seems the most reliable of all, and that also most completely meets other conditions except that of paralleling general thinking tendencies, is the weighted geometric mean index, in which the weights are roughly proportional to the reliabilities of the price ratios. This requirement as to weights is practically no limitation at all, as it is regularly approximated to by customary weighting devices. Practically without exception the observations of Mitchell (1915) as to what items to include in an index and what weights to give, are statistically equivalent to weighting price ratios according to reliability. As soon as a commodity becomes archaic the proper thing to do is to withdraw it, and withdrawals and entrances are readily accomplished with the geometric index. The weighted geometric mean index formula is

$$i=\sqrt[\Sigma w]{\frac{(p^1{}_1)^{w_1}\,(p^2{}_1)^{w_2}\;.\;.\;.\;(p^n{}_1)^{w_n}}{(p^1{}_2)^{w_1}\,(p^2{}_2)^{w_2}\;.\;.\;.\;(p^n{}_2)^{w_n}}}.\quad\text{(Index formula 5)}$$

For convenience, and without any loss of generality, Σw may be made to equal 1. Thus, letting $\omega_1=w_1/\Sigma w$, $\omega_2=w_2/\Sigma w$, etc., and as before. $\rho_1=p^1{}_1/p^1{}_2$, etc.,

$$i=\rho_1^{\omega_1}\,\rho_2^{\omega_2}\;.\;.\;.\;\rho_n^{\omega_n}.\quad\text{(Index formula 5a)}$$

Note that with this formula the index is reversible and that there is complete freedom in changing the base. Assuming as before that there is no correlation between ratios, the probable error is given by

$$P.\,E._{\cdot i}=.6745\frac{i}{\Sigma w}\sqrt{\frac{w^2{}_1\sigma^2{}_1}{\rho^2{}_1}+\frac{w^2{}_2\sigma^2{}_2}{\rho^2{}_2}+\;.\;.\;.\;\frac{w^2{}_n\sigma^2{}_n}{\rho^2{}_n}}\quad\text{(Probable error of the weighted geometric mean index)}$$

in which the ρ's are successive price ratios and the σ's their standard deviations. As an approximation, the σ's may be considered to be equal to each other and to equal the standard deviation of the distribution of price ratios. In order that this probable error remain small, it is necessary that no one of the ratios w_1/ρ_1, w_2/ρ_2, etc., be exceptionally large.

$$\frac{w_1}{\rho_1}=\frac{w_1p^1{}_2}{p^1{}_1}.$$

Letting $q^1{}_1$ equal the quantity of the commodity consumed, or in trade, it would be expected that $q^1{}_1p^1{}_1$ would fluctuate much less than $p^1{}_1$, and whereas there might be danger of $p^1{}_1$ becoming extremely small or large there is not equal liklihood of $q^1{}_1p^1{}_1$ doing so. Accordingly, if w_1 is approximately $=q^1{}_1p^1{}_1$, then $w_1/\rho_1=q^1{}_1p^1{}_2$, a magnitude which is not likely to be extremely large. However, should a commodity change greatly in its relative importance, the weighting of it may easily be changed as follows:

Let it be desired to change the weight of the price ratio ρ_1 from w_1 to W_1, which we will say is a smaller weight. We need not impose the condition that $\rho_1=i$. For $\rho_1 > i$ we will search the list of price ratios for (a) a ratio $> i$ which is underweighted, or (b) a ratio $< i$ which is overweighted. Suppose ρ_2 is such a ratio. Ordinarily there are a number of price ratios $=1.0$, or i, or some other value which is the modal value. These may be combined and represented by ρ^s, where ρ is this modal value and s the sum of the weights of all the ratios having this value ρ. Letting P stand for the product of all the terms other than ρ_1, ρ_2, and the ρ terms, we have

$$i=\sqrt[\Sigma w]{\rho_1{}^{w_1}\,\rho_2{}^{w_2}\,\rho^s\,P}$$

and it is desired to change this to

$$i=\sqrt[\Sigma W]{\rho_1{}^{W_1}\,\rho_2{}^{W_2}\,\rho^S\,P}.$$

The first index will equal the second in case

$$(1)\qquad w_1+w_2+s=W_1+W_2+S$$

and also,

$$(2)\qquad \rho_1{}^{w_1}\,\rho_2{}^{w_2}\,\rho^s=\rho_1{}^{W_1}\,\rho_2{}^{W_2}\,\rho^S,$$

or, taking logarithms,

$$w_1\log\rho_1+w_2\log\rho_2+s\log\rho=W_1\log\rho_1+W_2\log\rho_2+S\log\rho.$$

W_1 is the new weight that has been assigned (this may be zero) so that everything involved is known except W_2 and S, and the solution of the two equations simultaneously will yield these. Ordinarily S will differ but slightly from s, and W_2 will differ from w_2 in the direction in which it is desirable it should differ. Thus, as a practical matter, the weight of any price ratio, whether equal to i or not, may be changed without affecting the index.

No other index, as far as the writer can determine, offers the extreme flexibility in changing weights, dropping or adding new items, here found to exist for the geometric mean index. Since this is so, the weights can be made such that extreme ratios are given small weights or eliminated. As a consequence, the probable error of such a weighted geometric mean index may be expected to be smaller than that of any other index mentioned. The excellence of this index seems to the writer so great as to warrant its use, even though it involves a change in the established habits of interpretation of the usual reader.

Two criteria, the paralleling of habitual modes of thinking and reliability, have been proposed in judging the excellence of an index measure. Fisher (1913) has used eight other tests, three of them being tests only of "trade" indices. It would seem that these latter would be of particular importance only in case an index ceases to be a sampling and becomes an expression of the sum total of transactions involved. The table on page 836–7, in part taken from Fisher (1913), gives "scores" of the most important index measures upon several tests or criteria of excellence.

Test 1: Reliability. In giving scores upon this point the writer has freely used his judgment in the case of indices for which no simple probable error formula is available. More or less complete statistical analysis has preceded this scoring, but it is in no sense to be considered final. An "*s–i*" after a score means that no simpler way for calculating the probable error than by means of the correlation between comparable sub-indices seems to be available. As the writer judges this test to be the most important of all, the scoring is 3, 2, 1, and 0, instead of 2, 1, and 0—the larger the score, the higher the rating.

Test 2: Parallels habitual modes of thinking. Score 2, 1, 0.
The following tests are from Fisher.

Test 3: Proportionality. "A price index should agree with the price ratios if these all agree with each other." Stated algebraically:

$$\text{Given } \frac{p^1{}_1}{p^1{}_2} = \frac{p^2{}_1}{p^2{}_2} = \text{etc.} = i. \quad \text{Required that } \frac{P_1}{P_2} = i.$$

Score of 2 if true for any two years. Score of 1 if true only when year 2 is the base year.

Test 4: Entry and withdrawal. A price index should permit the entry and withdrawal of price ratios without changing the value of the index. Fisher uses a less general test: "A price index should be unaffected by the withdrawal or entry of a price ratio agreeing with the index." The scoring here follows Fisher, except for formula 5, which Fisher does not include in his list of 44, and for formulae 14 and 15 which are here scored higher than by Fisher.* Score 3, 2, 1, 0.

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* Fisher scores both of these formulae zero on the basis of entrance and withdrawal of items. It is, however, a simple matter to enter or withdraw price ratios, if the proper choice of weights is made. Proof for formula 15 is as follows:

To simplify notation, let

$$a=\Sigma p_1q_1$$
$$b=\Sigma p_2q_1$$
$$c=\Sigma p_1q_2$$
$$d=\Sigma p_2q_2$$

Then,

$$i=\sqrt{\frac{\Sigma p_1q_1}{\Sigma p_2q_1}\times\frac{\Sigma p_1q_2}{\Sigma p_2q_2}}=\sqrt{\frac{ac}{bd}}.\quad \text{(Index formula 15)}$$

Consider first the case of entering a price ratio which agrees with the index,

$$\rho_1=\frac{p^1_1}{p^1_2}=i,$$

and let it be desired to enter it with the weight q_1 in year 1. It is required to determine q_2 so that this new price may be included without changing the value of the index. Since $\frac{p^1_1}{p^1_2}=\frac{p^1_1q^1_1}{p^1_2q^1_1}=\frac{\sqrt{ac}}{\sqrt{bd}}$ therefore $p^1_1q^1_1$ is equal to some constant, k, times $\sqrt{ac}$, and $p^1_2q^1_1$ is equal to the same constant times $\sqrt{bd}$, so we may write,

$$\left.\begin{matrix} p^1_1q^1_1=k\sqrt{ac}, & p^1_1q^1_2=j\sqrt{ac} \\ p^1_2q^1_1=k\sqrt{bd}, & p^1_2q^1_2=j\sqrt{bd} \end{matrix}\right\}\ \text{from which}\ \frac{q^1_1}{q^1_2}=\frac{k}{j}.$$

Introducing the new price, we have

$$\sqrt{\frac{a+k\sqrt{ac}}{b+k\sqrt{bd}}\times\frac{c+j\sqrt{ac}}{d+j\sqrt{bd}}}=\sqrt{\frac{ac}{bd}}.$$

It remains only to solve this for k in terms of j to find the ratio which must hold between q^1_1 and q^1_2 to enable introducing the price without changing the index. Algebraic reduction gives

$$\frac{k}{j}=\frac{ab(di-c)}{cd(a-bi)}=\frac{q^1_1}{q^1_2}.$$

We may therefore introduce a new commodity whose price ratio agrees with the index provided the quantities or weights are in the proportion shown. The following example is given as an illustration of the entirely reasonable weightings obtained. Here the $p^1_1q^1_1$ entered is large, being approximately one-tenth of the Σp_1q_1 term. Given

$$i=\sqrt{\frac{1800}{2000}\times\frac{2200}{2500}}=.889944$$

$$p^1_1=.20,\qquad q^1_1=1000$$
$$p^1_2=.2247333,\ q^1_2\ \text{is required.}$$

Solution gives $q^1_2=1236$, a very reasonable answer, as the ratio $\Sigma q_1/\Sigma q_2$ must very nearly equal 1000/1236, as it can hardly differ greatly from a/c or b/d, which equal $\frac{1000}{1222}$ and $\frac{1000}{1250}$ respectively.

The principle illustrated may be followed in introducing prices whose price ratio is not equal to the index. In such case k is not a rectilinear function of j, and if the introduced price ratio differs much from i quite absurd weightings might be required in order to preserve the value of the index. However, excepting only the weighted geometric mean index, this index lends itself the most readily to the introduction or withdrawal of items. The formula should be especially serviceable for chain indices.

$$i_{12}=\frac{\frac{\Sigma p_1q_1}{\Sigma p_2q_1}+\frac{\Sigma p_1q_2}{\Sigma p_2q_2}}{2}.\quad \text{(Index formula 14)}$$

By a procedure similar to the preceding for formula 15, it is found that a price ratio, equal to the index, may be introduced without changing the value of the index, if the weights or quantities q^1_1 and q^1_2 are in the ratio Σp_2q_1 to Σp_2q_2.

SCORES OF INDEX NUMBERS UPON BASIS OF SIX TESTS OF EXCELLENCE

Tests	(1) Type IA $\frac{1}{N}\Sigma\frac{p_1}{p_0}$ Carli Evelyn Economist Sauerbeck Soether	(2) Type IA $\frac{\Sigma\frac{p_1}{p_0}w}{\Sigma w}$ Young Falkner Dun	(3) Type IA $\frac{\Sigma\frac{p_1}{p_0}p_1q_1}{\Sigma p_1q_1}$ Palgrave	(4) Type II Median value of $\frac{p^1_1}{p^1_0}, \frac{p^2_1}{p^2_0}\ldots$ Edgeworth	(5) Type II Weighted median	(6) Type III also Type V $\frac{\sqrt[n]{p^1_1p^2_1\ldots}}{\sqrt[n]{p^1_2n^2_2\ldots}}$ Jevons Westergaard	(7) Type III also Type V Weighted geom. mean	(8) Type IV $\frac{\Sigma p_1}{\Sigma p_2}$ Bradstreet
1 Reliability Smallness of P. E.	.5s-i	1.5s-i	1. s-i	2.	3.	1.	3.	1.5s-i
2 Parallels habitual mode of thinking	1.	1.	1.	1.	1.	.5	.5	2.
3 Proportionality	2.	2.	1.	2.	2.	2.	2.	2.
4 Entry and withdrawal	2.	2.	1.	1.–	1.–	2.	3.	2.
5 Change of base	.0	.0	.0	1.–	1.–	2.	2.	2.
6 Change of unit of measurement	2.	2.	2.	2.	2.	2.	2.	.0
Totals	7.5	8.5	6.0	9.0–	10.0–	9.5	12.5	9.5

SCORES OF INDEX NUMBERS UPON BASIS OF SIX TESTS OF EXCELLENCE—*Continued*

Tests	(9) Type IV $\frac{\Sigma p_1 w}{\Sigma p_2 w}$ Lowe	(10) Type IV $\dfrac{\Sigma p_1 \frac{q_0+q_1}{2}}{\Sigma p^0 \frac{q_0+q_1}{2}}$ Edgeworth Marshall	(11) Type IV $\dfrac{\Sigma p_1 \sqrt{q_0 q_1}}{\Sigma p_0 \sqrt{q_0 q_1}}$ Scrope and Walsh	(12) Type IV also Type IA $\frac{\Sigma p_1 q_0}{\Sigma p_0 q_0}$ Scrope Sidgwick Sauerbeck Giffen	(13) Type IV also Type IH $\frac{\Sigma p_1 q_1}{\Sigma p_0 q_1}$	(14) Type VI Arith. average of (12) and (13) Sidgwick Drobisch	(15) Type VI Geom. average of (12) and (13)	(16) Type V $\dfrac{\frac{\Sigma p_1 q_1}{\Sigma q_1}}{\frac{\Sigma p_2 q_2}{\Sigma q_2}}$ Drodisch Rawson-Rawson	(17) Type V $\dfrac{\frac{\Sigma p_1 q_1}{\Sigma p_2 q_2}}{\frac{\sqrt[n]{q^1_1 q^1_1 \ldots}}{\sqrt[n]{q^1_2 q^1_2 \ldots}}}$ Nicholson Walsh
1	2.5s-i	2.5s-i	2.5s-i	2. s-i	2. s-i	2.5s-i	2.5s-i	2. s-i	2. s-i
2	2.	1.5	1.5	1.	.5	.5	1.5	.5	.5
3	2.	1.	1.	2.	1.	1.	1.	.0	.0
4	2.	1.	1.	2.	1.	1.	1.	.0	.0
5	2.	1.	1.	.0	.0	.0	1.	2.	2.
6	2.–	2.	2.	2.	2.	2.	2.	.0	2.
Totals....................	12.5–	9.0	9.0	9.0	6.5	7.0	9.0	2.5	4.5

Type IA: Arithmetic average of ratios
Type IH: Harmonic average of ratios
Type II: Median of ratios
Type III: Geometric average
Type IV: Quotient of aggregates
Type V: Quotients of functions of data of single years
Type VI: Composites of preceding types

Test 5: Change of base. "The ratios between price indices should be unaffected by reversing or shifting the base." Algebraically stated: Let $i_{12}=\frac{P_1}{P_2}$, $i_{45}=\frac{P_4}{P_5}$, etc. Required that $\frac{i_{34}}{i_{14}}=\frac{i_{32}}{i_{12}}=\frac{P_3}{P_1}=i_{31}$. Give score of 2 if true for any two years, score of 1 if only true when the base year and one other is involved, *i. e.*, if only such equations as $\frac{i_{33}}{i_{13}}=i_{31}$, $\frac{i_{22}}{i_{42}}=i_{24}$, etc., hold.

Test 6: Change of unit of measurement. "The ratios between various price indices should be unaffected by changing any unit of measurement." Score of 2 or 0.

Fisher has a "Determinateness" test which he describes in the words, "A price index should not be rendered zero, infinity, or indeterminate by an individual price becoming zero." This is but one phase of reliability and is therefore included in Test 1 above.

In the formulae listed the q's stand for quantities of commodities consumed or in trade and are weights of the p's. When weights not exactly equal to the q's are involved, the symbol w is used. It is of course assumed that care would be exercised in selecting these weights w. p_0 and q_0 instead of p_2 and q_2 are used in those formulae in which the treatment of the data for the base year is unique. Test 5 is not completely met by any such formulae.

Formulae 7 and 9, which are given the highest scores, involve weights, w, instead of quantities, q. There is great flexibility in each of these so that if a weight is adopted, let us say in the first instance upon the basis of quantities (if using formula 9) or values (if using formula 7) in trade, which tends to become unreasonable, it can be changed without affecting the index between the year when the change is made and the preceding year. If years from early to late are designated by 1, 2, 3, 4 and if a formula 7 index number is started at the end of the first year, using weights proportionate to the values of the commodities in trade, and continues until the beginning of year 4 before a change in weights is desirable, a change can at that time be made which will preserve the index i_{34} and its reciprocal i_{43}. The new weighting would probably give an i_{42} and an i_{41}, were they to be calculated, which would be slightly different from those given by the equations:

$$i_{42}=\frac{i_{43}}{i_{23}} \text{ and } i_{41}=\frac{i_{43}}{i_{13}}$$

which would exactly hold had no change in weights been made. This difference will usually be small, but if an index permitting changes in weightings and at the same time enabling the use, without approximation, of any year as base is demanded, it may be made by the expenditure of a little more labor.

Formula 12 (or 13) in which there are no parameters, or flexible weightings, will serve as a foundation:

$$i_{12}=\frac{\Sigma p_1q_2}{\Sigma p_2q_2}.$$

Let M_1 = the mean of the p_1's

m_1 = the mean of the q_1's

S_1 = the standard deviation of the p_1's

s_1 = the standard deviation of the q_1's

r_{11} = the correlation between the p_1's (represented by the first subscript) and the q_1's (represented by the second subscript).

Symbols with other subscripts have comparable meanings, *e. g.*, r_{24} = the correlation between the p_2's and the q_4's. Then,

$$\Sigma p_1q_2=N(M_1m_2+r_{12}\,S_1\,s_2)$$
$$\Sigma p_2q_2=N(M_2m_2+r_{22}\,S_2\,s_2).$$

Consequently, the numerator and the denominator for the index between any two years may be built up if the means, standard deviations, and correlations are known. The data required may be calculated each year, as the data for the years become available, and tabulated in such a table as the following:

DATA FOR DETERMINING INDEX WITH ANY DESIRED YEAR AS BASE

Years		Mp	Mq	$-S$	s	rpq: p for year indicated in stub and q for number of years indicated earlier (−) or later (+)												
						−32	−16	−8	−4	−2	−1	0	+1	+2	+4	+8	+16	+32
1919	9	+		+						+								
1918	8																	
1917	7	*	+×*	*	+×*							*						
1916	6																	
1915	5																	
1914	4																	
1913	3																	
1912	2																	
1911	1	×		×												×		

If it is desired to make 1917 the base and to express the prices in 1919 and 1911 relative to it, then Σp_9q_7 is determined from the magnitudes recorded in the compartments in which there is "+"; $\Sigma p_1 q_7$ from the compartments in which there is "×"; and $\Sigma p_7 q_7$ from the compartments in which there is "*."

The table as drawn up does not provide space for all the possible correlation coefficients. With such care as could be taken in choosing the units of quantity, the correlation coefficients could be made to vary from year to year in a very regular manner, thus enabling interpolation with high accuracy. There is complete freedom in changing the weights of commodities, but it should be noted that a commodity "dropped" continues as one of zero price and zero quantity—in other words, the N has not been decreased by "dropping" the commodity. To change the weight of a commodity price from w to w' demands a warrant. Let us say that such warrant is found in the ratio of the quantities consumed. No less warrant is necessary when w' is zero. An article once included in the index should come out only in case it becomes practically obsolescent. No distortion of any index would result in this case. We may of course take out a commodity under other conditions without affecting some one particular index.

Formula 13, particularly serviceable if trade indices are involved, may be derived from the table of constants giving a formula 12 index.

The number and nature of the commodities entering into an index is a function of the accuracy required and of the particular purpose to be served by the index. Ruling out of consideration the index which is based upon a complete survey of a field the question is, what are the principles which should control in drawing a sampling? The fundamental principles of multiple correlation apply—high correlation with the purpose to be served and low intercorrelation. If a coal price index is being constructed from a small number drawn from a much larger number of quotations, the quotations should be chosen so that (a) each is as little correlated as possible with the other quotations included in the index, and (b) each is as highly correlated as possible with the other quotations in the field not included in the index. It is to be expected that commercial tendencies will conspire to prevent any quotation from markedly possessing both characteristics, in which case a balance must be struck between them: (b) is the more important if the number of quotations in the index is mall, say not over six, but (a) is by far the more important if the number of quotations is large. In fact, quotations that are excellent for incorporation in an index number based upon a small number of items may be expected to be relatively inferior for incorporation in an index based upon a large number of items. This brief observation as to the significance of correlation between commodity prices is, in the main, an addendum to, not in opposition to, the points involved in Dr. Mitchell's (1915) very thorough exposition of the question of what commodities should be included.

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THE MEASUREMENT OF THE RELATIVE ECONOMIC STATUS OF FAMILIES

By Edgar Sydenstricker and Willford I. King

For many centuries people have been spoken of as being rich, well-to-do, or poor. Within broad lines, and for a given time and place, this classification conveys a distinct meaning; but it is not accurate enough for use in scientific analysis. In careful economic research it is insufficient to put into the same class a billionaire and the village banker, even though both are commonly spoken of as rich men. Similarly, the well-to-do and the poor must be divided into subclasses so that different grades of comfort or poverty may be distinguished. How can this subdivision be successfully accomplished?

The usual reply to this query is that it is easy enough to make such a comparison by using income as a criterion. This answer, however, although it appears specific enough is, in reality, extremely vague and indefinite. How is this income comparison to be carried out? How shall we compare the income of the school boy who earns nothing with that of the delivery boy who works by the month? Is the delivery boy rich and the school boy poor? It is perfectly apparent that no such condition can be assumed to exist, for the school boy's parents may be rich and may furnish him with an abundance of everything he needs, while the delivery boy may receive only bare necessities. Evidently, then, personal earnings are entirely unsatisfactory as a criterion of income, and if we would compare individuals as to well-being, we must study the income of the family as a whole and not merely that of the individuals composing it.

This important truth has, unfortunately, been ignored by certain investigators who have assumed that the man who gets good wages is necessarily of a higher income class than the man who gets poorer pay. The exceptions to such a rule are, however, so numerous as largely to invalidate all conclusions based thereon. The determination of individual earnings must, therefore, for purpose of comparing welfare, be regarded as merely a step preliminary to the computation of the net family income.

As most accountants and statisticians can testify, the computation of the family income is in itself a task of considerable difficulty, especially when the facts concerning the family are not all perfectly clear—a condition which is certain to prevail when one deals with data collected rather rapidly from a large number of families. The following are a few of the difficulties involved:

1. One must differentiate carefully between business expenses incurred in obtaining the net income and consumption expenses paid for out of net income.

2. One must be careful to exclude the income of boarders and visitors who are not part of the economic family even though they are temporarily living under the same roof and sharing in the same food supply.

3. One must include only profits (and not gross receipts) accruing from boarders, lodgers, gardening operations, the rearing of live stock, etc.

But the correct computation of net family income is not the problem here under discussion. Let us assume, therefore, that all such difficulties have been overcome and that the family income has been accurately computed. The real problem—that of comparing families as to their respective income conditions—still awaits solution. An illustration of the difficulties involved may prove helpful. Let us first suppose that the Smiths have an income of $2,000 a year and that the Clarks have only $1,800. Which family is better off financially? Manifestly, some data is necessary before the question can be answered. If the Clarks have four children and the Smiths have six, the Smiths are probably poorer than the Clarks. The size of the family is, then, evidently a factor of prime importance.

The solution now appears simple: The Smith family consists of eight persons and the Clark family of six; therefore $\frac{\$2,000}{8} = \$250$ per capita, while $\frac{\$1,800}{6} = \$300$ per capita. The Clarks are, therefore, apparently slightly richer than the Smiths. But let us not be too quick in accepting this conclusion. The Clarks have two children who are nearly grown, attend high school, go to parties, and wear fashionable clothes, whereas the Smith children are all under twelve years of age. Are we sure now that the Clarks are in the better economic circumstances? Such a conclusion is by no means dependable. Evidently the age of the members of the family must also be considered a factor of very great importance.

Furthermore, the Smith children may be all boys and the Clark children all girls, and this fact will certainly affect the quantities of food and clothing required. Sex, therefore, is another factor which affects expenditures much too radically to be safely ignored. When all of these circumstances have been carefully considered, it no longer appears at all easy to say which family's income enables it to supply more fully its economic needs and wants.

In 1916, when one of the present writers (E. S.) was called upon to make a detailed study of the economic conditions of the population residing in seven cotton mill villages of South Carolina, he was confronted with the need for a reasonably accurate mode of determining the relative income status of each family. Realizing that ratings made according to either total family income or per capita income would be entirely too crude for the purposes in hand, he immediately began to search for some device which would give more satisfactory results. What he needed, he decided, was a scale for each sex showing average relative total maintenance expenses for persons of different ages. No such scales, however, could be found. Nevertheless, there did exist several pairs of scales purporting to show the relative food consumption according to age and sex.

Scales of this last type were not new, for as early as 1795 Foley suggested the idea of constructing them. However, the earliest ones for which the actual records could now be found were those used by Ernst Engel in 1895. He had based his scales primarily upon the variations of individuals in weight per centimeter of height. He proposed that the food requirements of a child in its first year be selected as the unit and that this unit should be called a "quet" in honor of Quetelet.* B. Seebohm Rowntree had rated, in somewhat the same fashion, the families which he studied in York.† The scales found to be most familiar to Americans were those devised by W. O. Atwater and his associates in the United States Department of Agriculture. They were worked out from data obtained through a combination of feeding experiments and budgetary studies‡ and had, in recent years, been rather widely used. The Atwater study deals with food supply in terms of calories. The unit (known as the Adult Male Unit, and hereafter designated as the A. M. U.) is defined as the need for heat and energy from food to the extent of the average number of calories required to keep a normal young man who is engaged in moderate muscular work in a proper state of health and vigor.

Although scales showing all expenditures rather than merely the needs for food in calories were the things actually sought, still, in their absence, the feasibility of substituting therefor the Atwater food scales was deemed worthy of consideration. It was of course evident that the relative food requirements in calories were not at all the same thing as relative total monetary expenditures for all consumption needs, yet it seemed that they might not differ from each other very widely after all. One would scarcely expect differences in age and sex to have an effect upon food expenses different from that which they had upon food needs in calories. It is also quite evident that food is such an important item in the family budget that it cannot fail to play a very important part in determining the distribution of all expenses. Besides, it seemed not unreasonable to suppose that the cost of other articles such as housing, fuel, light, clothing, and furniture, might be divided among persons according to age and sex in much the same proportions as is food.

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* *Lebenskosten Belgischer Arbeiterfamilien:* Bulletin de L'Institut Internationale de Statistique, vol. ix.

† See *Poverty, A Study of Town Life*, chap. viii.

‡ See *Farmers' Bulletin* 142, p. 33, published by the United States Department of Agriculture.

On the assumption that the disparity was at least not likely to be startling, it was determined to use, during the preliminary investigation, the Atwater scale for measuring the relative sizes of the respective families as expending units. Following this plan, the fraction of an adult male unit for the given age and sex was computed for each person, the fractions thus derived for the various members of a family were added together, and the resulting sum was used as the preliminary estimate of the relative size of the family. This method was applied to all of the families studied. The total income for each family was then divided by the total number of adult male units therein and the resulting quotient, the income per A. M. U., was taken as the economic rating of all members of the household. The households were then classified into income groups having an interval of $4.00 monthly per A. M. U.

In 1917 the present writers, who were working together, both agreed that the data collected in 1916 and 1917 would furnish a good basis for the construction of scales of the type that had been vainly sought, namely, those showing the actual relative total expenditures for persons of various ages and sexes. It was determined, therefore, to attempt the derivation of such scales.*

The preliminary step was to divide total family expenditures into two parts, namely, food and other, and to work with each part separately. The first part of the main procedure was to derive scales showing the actual average relative expenditures for food for the different ages and sexes. The method decided upon was to use the Atwater scale as a starting point and to make such corrections therein as experience proved to be necessary.

Following this policy, the total food expense per week for each household was divided by the number of A. M. U.'s, which gave the food expense per A. M. U. for each household. It will be remembered that all the families had been classified upon the basis of approximate monthly income per A. M. U. and were divided into classes having an interval of $4.00. Each income class was dealt with separately.

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* For the original report of this investigation see the article entitled, "Income Classification of Families in Studying Disease Prevalence," *United States Public Health Reports*, November 26, 1920.

Within each income class the percentage of the household which was female was determined, and the families were classified upon this basis. Within each of these subclasses, the average expenditure per A. M. U. for food was determined. These averages were reduced to indices by using the average for the entire income class as a base. The indices for the separate income classes were then averaged, each being weighted according to the respective numbers of A. M. U.'s in the various income classes. The resulting index series showed a tendency to rise slightly as the percentage of the family female grew larger. This indicated the necessity of increasing the relative importance of females in making allowances for food costs. By dividing the Atwater scale for females by 0.964, the resulting quotients were such that when applied they seemed to cause the curve to conform as closely as possible to the actual relative value of food purchased for consumption by females as compared to the similar food value for males.

The adjustment for sex having been made, the next step was to find out what adjustments, if any, should be made for age. The income classification of the families as described above was retained without change. The families within each income class were next divided into three main divisions, namely, families composed of two adults and several children, families composed entirely of adults, and other families. Families in the last division were discarded as being not adapted to the purpose of this study. Families with children were subdivided according to the ages of the children. Families composed of adults were classified according to the average age of the adults. The average money value per A. M. U. of food purchased for family consumption was now compared for different ages, and it was found to be materially less in each income class for old people than for young adults, and to be slightly higher for children than the necessary food supply as indicated by the Atwater scale. A separate index series was obtained for each income class and a weighed arithmetic average of these series of indices was computed. The resulting average series for all classes furnished a series of adjusting factors to be applied to the already once adjusted Atwater scales. Multiplication by these factors produced a pair of scales which purported to show the actual relative expenditures for food for persons of different sexes and various ages.

Since these scales were derived from actual money expenditures for food rather than from the number of calories believed to be necessary for the maintenance of an individual, it was thought best to give a distinctive name to the unit upon which these original scales were based. The term chosen was *fammain*, it being an abbreviation of the phrase *food for adult male maintenance*. The fammain may be accurately defined, for any given class of people, as *a demand for food of a money value equal to that demanded by the average male in the given class at the age when the expense for his food reaches a maximum.*

It will be noticed that the fammain is quoted as a *demand for* rather than a *purchase of* food. The fammain is conceived of as a psychological attribute of the individual which continuously requires nourishment for its satisfaction. The food purchased depends upon vicissitudes of all kinds and is a most variable thing, whereas the demand is relatively constant.

As stated before, the 1916 investigation was purely preliminary and was intended largely for the development of modes of procedure. The schedules obtained were, therefore, as might be expected, incomplete in certain particulars, and the possible accuracy of the information therefrom was necessarily limited by these imperfections. For instance, the value of home-produced foods had not been calculated and added to the value of purchased foods. Such errors were, wherever possible, eliminated in the 1917 study. As a result, although it has of course been impossible to eliminate from 1917 data certain types of errors which are inseparable from an extensive budgetary study, it is believed that the errors arising in 1916 from the tentative nature of the method and from incompleteness in the calculations have been reduced until they are reasonably small.

With these improved schedules on hand, the next move was to correct the scales of fammains as derived from the 1916 study. The mode of correcting these scales was similar in concept but different in mechanical procedure from that used in making adjustments from the Atwater scale. As a material basis for the work of correction, budgets from about a thousand families were selected and actually used in the computations from which the accompanying indices are derived. These families were resident in twelve South Carolina mill villages, and the schedules were taken in the spring of 1917 before garden produce became abundant. For each family the number of fammains (computed according to the 1916 scales) was added up. The total food expense was divided by the number of fammains to obtain the expense per fammain.

It was absolutely necessary that variations in food supply owing to wide differences in income be eliminated; hence a classification of the families on an income basis was essential. Since it was entirely superfluous as well as impracticable to make this classification at all exact, the approximate method of dividing the total weekly family income by the number of fammains was used. This income per fammain, not strictly scientific as a basis of income classification, was amply accurate for the purposes at hand.

Next, the percentage of all members who were male was ascertained for each family. The expense per fammain for food for the family was then plotted as an ordinate against the percentage of the family male as an abscissa. This was repeated for each family. A straight line was next fitted as closely as possible to the trend of the points located. The tangent of its angle with the horizontal was then measured. The tangents thus obtained showed that the fammain scales derived from the 1916 schedules still failed to allow a sufficient amount for the necessary consumption for females as relative to that of males, the fraction shown being about 3 per cent less than actual relative value of food intended for consumption. All percentages on the 1916 fammain scale for females were therefore multiplied by 1.03.

The next necessary step was to test the 1916 fammain scale for correctness as to age relationships. This was done in the following manner: All families were divided into income classes having an interval of $1.00 weekly per fammain. For each family within a given income class, the quantity representing food expenditures per fammain was plotted as an ordinate against the average age of the persons in the family. After the points were plotted, the graph sheet was divided into age classes and the median expenditures for each age class was determined. Indices were now derived by dividing the median for each age class by the median for all the age classes. This process was repeated for each income class. The indices thus derived were weighted according to the number in each subclass and the weighted arithmetic average of all the indices within a given age class was obtained for all income classes. These average indices for the various age classes, when compared, showed clearly that the 1916 fammain scales had assigned too small a rating in fammains for the older persons. The fammain scales were therefore adjusted for age as well as for sex. They now purported to show for each sex the correct rating of normal relative expenditures for food at different ages.

Since the changes made had been considerable, however, it seemed best to verify the results and to ascertain whether after the new adjustments were made, the scales actually represented the facts. The number of fammains was therefore recomputed for each of the thousand selected families according to the new scales. Again, food expenditures per tentative fammain were compared for different age classes. It was found that a small further allowance must still be made for persons of

Table I

FINAL SCALES OF FAMMAINS

Derived from Food Records of 1500 Families Collected in 1917 from Residents of Twenty Cotton Mill Villages of South Carolina.[1]

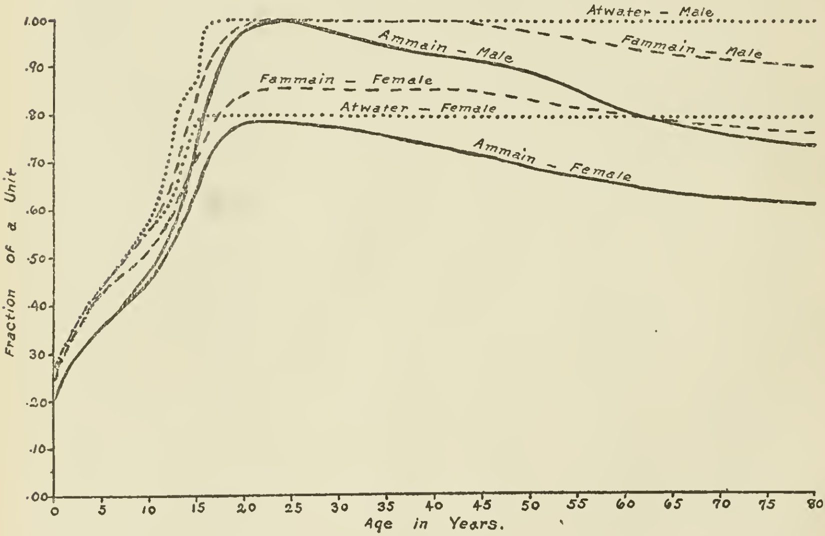
Age in Years	Male	Female	Age in Years	Male	Female
Under 1	.278	.265	40	1.000	.858
1	.302	.289	41	1.000	.858
2	.348	.335	42	1.000	.858
3	.381	.371	43	.999	.857
4	.410	.403	44	.997	.854
5	.435	.427	45	.994	.851
6	.460	.447	46	.991	.848
7	.483	.463	47	.988	.845
8	.506	.478	48	.985	.842
9	.531	.492	49	.982	.839
10	.557	.517	50	.979	.836
11	.592	.541	51	.976	.833
12	.639	.576	52	.973	.830
13	.694	.615	53	.970	.827
14	.769	.660	54	.966	.824
15	.837	.715	55	.962	.821
16	.900	.760	56	.958	.818
17	.935	.795	57	.955	.815
18	.965	.820	58	.952	.812
19	.983	.835	59	.949	.809
20	.991	.845	60	.946	.806
21	.998	.853	61	.943	.803
22	1.000	.858	62	.940	.800
23	1.000	.858	63	.937	.797
24	1.000	.858	64	.935	.794
25	1.000	.858	65	.933	.792
26	1.000	.858	66	.931	.790
27	1.000	.858	67	.929	.788
28	1.000	.858	68	.927	.786
29	1.000	.858	69	.925	.784
30	1.000	.858	70	.923	.782
31	1.000	.858	71	.921	.780
32	1.000	.858	72	.919	.778
33	1.000	.858	73	.917	.777
34	1.000	.858	74	.915	.775
35	1.000	.858	75	.913	.774
36	1.000	.858	76	.911	.772
37	1.000	.858	77	.909	.771
38	1.000	.858	78	.907	.770
39	1.000	.858	79	.905	.769
			80	.903	.768

[1] The last decimal place is, in every instance, the result of interpolation and cannot be regarded as accurate.

ages above 34 years. The number of fammains was therefore increased slightly for the higher ages. The ratio between the sexes seemed to be as accurate as could be arrived at; hence no changes were required on this account. The scale as finally adjusted is believed to represent fairly the relative variation with age and sex of expenditures for food under the conditions prevailing in South Carolina cotton mill villages in the spring of 1917.

A glance at the accompanying graph shows that the fammain and the Atwater scales diverge from each other considerably in places. This leads us to inquire whether or not this divergence is a result of the Atwater scale being based upon measurements in terms of calories, while the fammain scale is based upon money value.

THE AMMAIN AND FAMMAIN CURVES,
REPRESENTING CONDITIONS IN THE SOUTH CAROLINA COTTON MILLS IN 1917,
AS COMPARED TO GRAPHS OF THE ATWATER SCALES



It is evident that unless the food of females costs more per calorie than does that of males, or vice versa, or unless the cost of food per calorie varies with age, the calorie curve and the fammain curve must be identical. In order to ascertain whether costs per calorie actually do or do not vary with age and sex, about twelve hundred families were classified on the basis of those variables, and the food supply of each class was studied as to its calorific content. The results showed no correlation whatever between either age or sex and the food cost per calorie. The conclusion must be that the fammain curve represents the demand for food equally well, whether it is expressed in terms of calories or of money cost. This interchangeable character makes the fammain scale doubly useful.

But food is only one of the items of the family budget. Any scale adequate for use in the accurate classification of families upon an income basis must take into consideration expenditures for other purposes as well. Now articles of different kinds can be added only when all are first reduced to a common denominator. The only common unit of measurement for food, clothing, entertainment, etc., which can be readily applied to the various articles is the dollar's worth; hence it was necessary to consider food as well as all other classes of commodities in terms of money value. It was certainly impracticable, and probably wholly useless as well, to attempt to ascertain the quantities of the various articles actually *consumed* by individuals. It proved feasible, however, to secure the housewife's estimate of the amount and value of each class of articles, except food, purchased for the various members of the family for purposes of current consumption during the preceding twelve months, and inquiries were made to this end. The ultimate object was to secure indices showing the relative purchases of the articles to be used by persons of different ages and sexes, and then to combine these indices with similar ones for food. The ordinary schedules taken in 1917 covered expenditures for food only. It was therefore necessary to undertake a special inquiry to ascertain how other expenditures were apportioned among individuals of different ages and sexes. For this purpose information was secured from some three hundred families, an estimate being obtained from some member of each family, usually the housewife, of the total expenses incurred during the preceding twelve months for each of thirty of the leading categories of purchases for the family budget, these categories including only articles of such a nature that they could readily be apportioned to individuals, as, for example, various articles of clothing, medical expense, recreation, and schooling. In addition, a statement was obtained of the family expense incurred for rent, fuel, light, and twenty-eight minor items. By use of the data thus obtained from the family, together with records secured from the merchants of the food sold from their stores to each family during sample periods, an effort was made to balance the family income and expenditures for the twelve-month period before the schedule was taken. Nearly half of the schedules failed to balance within a reasonable margin of error. All such schedules were rejected, leaving for consideration reasonably satisfactory schedules for 140 families comprising 672 individuals. These 140 families were classified upon the basis of income per fammain (using the 1916 scale which was satisfactory enough, since for the purpose in hand it was necessary to obtain only a very crude approximation to the actual income rating of the family). The individual items for the persons of each sex within a given income class were plotted one by one, using age as an abscissa and actual expenditures for the given person's individual needs as ordinates. By a modification of the moving average method, a smoothed curve was derived for each income class from the points indicating the positions of the various items. These curves were weighted according to the number of individuals in each income class and were thereafter combined into one curve which was then smoothed. The quantities entered in Table II were read from this curve.

The index series for food was now combined with the similar series for expenditures for other articles purchased specifically for individuals, each series being weighted in proportion to the average money expended for all the individuals of each sex for food and for other articles respectively. The combined index is recorded in Table III. It takes into consideration all of the principal ordinary expenditures except those for rent (a small expense in mill villages), fuel and light, and furniture, and actually includes about 89 per cent of the total family expenditures. It seems probable that the remaining 11 per cent is apportioned in a ratio sufficiently similar to that representing the items used in deriving the scales just mentioned to make these scales fair criteria of the ordinary relative expense for maintenance of individuals of different ages and sexes among the families studied.

These scales evidently differ from the fammain scales and have a different unit as a base. The unit, in this instance, may be defined for any given class of people, as a *gross demand for articles of consumption having a total money value equal to that demanded by the average male in that class at the age when his total requirements for expense of maintenance reach a maximum.* This unit may be denominated as an *ammain.* It differs from the "adult male unit" of the Atwater scale in that it is based upon demand for all maintenance and not merely upon that for food, and in that it is a measure of *money value* of actual expenditures and not of *calories* to meet bodily needs. It differs from the fammain only in that it includes all expenditures and not merely those made for food. The term *ammain* is an abbreviation of the words *adult male maintenance.* The excuse for the coinage of the terms *ammain* and *fammain* lies only in the fact that the concepts included therein cannot be expressed accurately in ordinary English except by long descrip-

Table II

RELATIVE EXPENDITURES FOR PERSONS OF DIFFERENT AGES AND SEXES FOR ARTICLES PURCHASED FOR USE BY A SPECIFIC INDIVIDUAL

As shown by the Budgets of 140 Families in the Cotton Mill Villages of South Carolina for a Twelve Month Period Ending in 1917.

Age in Years	Male	Female	Age in Years	Male	Female
			40	.81	.45
Under 1	.11	.11	41	.80	.44
1	.13	.13	42	.79	.43
2	.16	.16	43	.79	.41
3	.17	.17	44	.78	.40
4	.19	.18	45	.78	.38
5	.20	.19	46	.77	.37
6	.22	.21	47	.76	.36
7	.24	.23	48	.76	.35
8	.26	.25	49	.75	.35
9	.28	.27	50	.74	.34
10	.31	.30	51	.73	.33
11	.33	.33	52	.71	.33
12	.35	.37	53	.69	.32
13	.40	.40	54	.67	.32
14	.46	.44	55	.64	.31
15	.55	.48	56	.62	.30
16	.65	.57	57	.61	.30
17	.77	.60	58	.60	.29
18	.86	.61	59	.58	.29
19	.92	.63	60	.57	.28
20	.95	.63	61	.56	.28
21	.96	.63	62	.55	.27
22	.98	.62	63	.54	.27
23	.99	.62	64	.53	.27
24	1.00[a]	.61	65	.52	.26
25	1.00	.60	66	.51	.26
26	.99	.60	67	.51	.26
27	.97	.59	68	.50	.26
28	.95	.59	69	.49	.26
29	.94	.58	70	.49	.26
30	.92	.58	71	.48	.26
31	.91	.57	72	.47	.25
32	.89	.55	73	.47	.25
33	.88	.54	74	.46	.25
34	.87	.52	75	.46	.25
35	.85	.50	76	.45	.25
36	.84	.49	77	.45	.25
37	.83	.48	78	.44	.25
38	.82	.47	79	.44	.25
39	.82	.46	80	.43	.25

a. Average expenditure for a man 24 years of age = $ 100.79

tive sentences, and experience has amply proved that it is far better to coin words outright than to use existing words capable of double interpretations.

It will be observed that the scales of fammains, as might be expected, differ but slightly from the Atwater scales which represent basal food requirements in calories, while the scales for ammains are distinctly dissimilar to those representing expense for food or necessary food requirements.

Table III

FINAL SCALES OF AMMAINS

Derived from Complete Budgets of 140 Families and from Food Records of 1500 Families Collected in 1917 from Residents of Twenty Cotton Mill Villages of South Carolina.[1]

Age in Years	Male	Female	Age in Years	Male	Female.
Under 1	.220	220	40	.931	.739
1	.241	.241	41	.928	.735
2	.281	.281	42	.925	.731
3	.306	.306	43	.922	.727
4	.332	.332	44	.919	.723
5	.352	.352	45	.916	.718
6	.375	.375	46	.912	.713
7	.397	.396	47	.908	.708
8	.419	.412	48	.904	.703
9	.442	.429	49	.899	.698
10	.470	.451	50	.894	.693
11	.499	.481	51	.888	.689
12	.537	.514	52	.881	.685
13	.590	.553	53	.873	.681
14	.657	.596	54	.864	.677
15	.736	.648	55	.854	.673
16	.812	.705	56	.844	.669
17	.876	.739	57	.834	.666
18	.928	.760	58	.825	.663
19	.960	.776	59	.818	.660
20	.976	.783	60	.812	.657
21	.986	.789	61	.807	.654
22	.992	.790	62	.802	.651
23	.996	.790	63	.797	.648
24	1.000	.788	64	.792	.645
25	1.000	.786	65	.788	.642
26	.996	.784	66	.784	.639
27	.990	.782	67	780	.636
28	.984	.780	68	.776	.634
29	.978	.778	69	.772	.632
30	.972	.776	70	.768	.630
31	.967	.773	71	.764	.628
32	.962	.770	72	.760	.626
33	.957	.767	73	.757	.625
34	.952	.763	74	.754	.623
35	.948	.759	75	.751	.622
36	.944	.755	76	.749	.620
37	.940	.751	77	.747	.619
38	.937	.747	78	.745	.618
39	.934	.743	79	.743	.617
			80	.741	.616

[1] The last decimal place is, in every instance, the result of interpolation and cannot be regarded as accurate.

Although the ammain and fammain scales here presented are probably fairly representative of expenditures for persons of different ages and sexes among the cotton mill workers of South Carolina, it does not follow that the same relative expenses of maintenance would be strictly applicable to other classes of workers. The existence of such similarities or differences can be determined only by investigation. It might be said, however, that for the families considered in the present study, differences in income did not seem radically to affect the character of the scales. However, there were too few families of high income to afford an adequate basis for any definite conclusions as to whether extreme income variations do or do not have any tendency to modify the shape of the curves. It seems not improbable, nevertheless, that in social classes differing widely from those studied, expense for clothing for different ages and sexes might noticeably diverge from the present scales. The scales here cited, therefore, although believed to be reasonably accurate for the given class of workers in the locality under consideration, may prove somewhat inaccurate if applied to different classes of persons or to the same class in other localities.

However, for studies in which it is impracticable to work out an original scale of ammains or fammains, it is evident that these scales may be used for the purpose of improving very notably the accuracy of the family income rating over that which could be secured simply by dividing the income for the family by the number of individuals composing it or, still more crudely, by merely using the income for the family as a whole.

In fact, for studies of working-class families anywhere, if the classification according to income does not need to be extraordinarily exact, it will probably be sufficient to use the present scales as they stand.

The practical method of applying the fammain and ammain scales is shown in the following example:

SMITH HOUSEHOLD

Name	Age	Sex	Position in family	Number of fammains	Number of ammains
John	38	M	head	1.00	.94
Mary	34	F	wife	.86	.76
Fred	12	M	son	.64	.54
Oliver	10	M	son	.56	.47
Clinton	8	M	son	.51	.42
James	6	M	son	.46	.38
Harry	4	M	son	.41	.33
George	2	M	son	.35	.28
Total for family				4.79	4.12

Total annual family income = $2,000
Income per ammain = $2,000 ÷ 4.12 = $485
Total annual expenditure for food = $600
Annual food cost per fammain = $600 ÷ 4.79 = $125

CLARK HOUSEHOLD

Name	Age	Sex	Position in family	Number of fammains	Number of ammains
Clark, Samuel	45	M	head	.99	.92
Clark, Edith	41	F	wife	.86	.74
Clark, May	18	F	daughter	.82	.76
Clark, Gladys	16	F	daughter	.76	.71
Clark, Julia	13	F	daughter	.62	.55
Clark, Evelyn	11	F	daughter	.54	.48
Jones, William	28	M	boarder	1.00	
Ross, Jennie	24	F	boarder	.86	
Total for dietary group				6.45	
Total for economic family					4.16

Total annual family income =$1,800
Income per ammain =$1,800 ÷ 4.16 = $434
Total annual expenditure for food = $780
Annual food cost per fammain = $780 ÷ 6.45 = $121

We can now proceed to answer intelligently the question propounded at the beginning of the discussion as to whether the Clark family is richer or poorer than the Smith family. A comparison of their respective incomes per ammain is all that is necessary. We see that although their per capita income is slightly less, the Smith family is distinctly better off, the ratio of their income to that of the Clark family being as $485 is to $434. A comparison of the respective values of food used per fammain shows us, however, that the members of the Clark family, perhaps because they keep boarders, perhaps for other reasons, have nearly as abundant a food supply as do the Smiths. The Clarks, then, must perforce economize more diligently than the Smiths in other lines of expenditure.

This study is presented with a full realization that it is only a beginning and not a finality in this field. Its prime object is to call attention to the absolute necessity of prefacing all attempts to classify families upon an income basis by ascertaining:

1. The age and sex composition of the family.
2. The number of ammains composing the family.
3. The total net income for the family.
4. The net family income per ammain.

If it is desired to make a comparison, not according to income but according to the food supply of the persons eating at the family table, the sequence of the steps then would become:

1. The age and sex composition of the dietary group.
2. The number of A. M. U.'s or fammains composing the dietary group.
3. The total number of calories or total value of food consumed by the dietary group.

4. The number of calories per fammain consumed or the number of dollars per fammain expended for food during the period in question.

With this information at hand it is possible to proceed intelligently with further investigations requiring, as a prerequisite, knowledge of the income, dietary conditions, or general economic welfare of the families in question. Without such a systematic rating of families, the results of income or dietary studies are always affected with such a wide margin of error as to cast serious doubt upon the accuracy of any except the most strikingly evident conclusions which may be derived therefrom.

A NEW METHOD OF APPORTIONMENT OF REPRESENTATIVES*

By Edward V. Huntington, *Harvard University*

I. THE CONSTITUTIONAL REQUIREMENTS

The only provisions of the United States Constitution which bear on the present problem of apportionment are the following: "Representatives shall be apportioned among the several states according to their respective numbers, counting the whole number of persons in each state, excluding Indians not taxed." "The enumeration shall be made within . . . every . . . term of ten years." "The number of representatives shall not exceed one for every 30,000, but each state shall have at least one representative."

Since fractional representation appears to be out of the question, the problem is how to distribute any given total number (N) of representatives among the several states in proportion to their populations "as nearly as may be."

In other words, considering first the case of two states, the problem is how to approximate most closely to the condition expressed by the proportion

$$A : B :: a : b,$$

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* The method here proposed was first presented at a meeting of the American Mathematical Society, December 28, 1920, and an abstract of the technical results will be published in the *Proceedings of the National Academy of Sciences*, probably in April, 1921.

The new method was brought to the attention of Congress through two letters to Chairman Isaac Siegel of the House Committee on the Census. The first (dated January 8, and published in the *New York Times* for January 16, 1921, Section VII) showed that in the apportionment bill for 483 members then pending, the relation between Missouri and Montana could be improved by changing from 16 and 2 to 15 and 3. The second (dated January 17, and published in the *Congressional Record* for January 19, 1921, page 1791) showed that in the revised apportionment bill for 435 members, which was eventually passed by the House but allowed to die in the Senate, the following improvements could be made:

	Old	New		Old	New		Old	New
New York	43	42	North Carolina	11	10	Virginia	10	9
New Mexico	1	2	Rhode Island	2	3	Vermont	1	2

Also, two letters to Senator Howard Sutherland, chairman of the Senate Committee on the Census, dated January 22 and 29, 1921, urged investigation of the new method, and in February Senator Sutherland referred the matter for advice to the Advisory Committee to the director of the census. The report of this committee is expected to be available before the apportionment bill is taken up afresh in the new session of Congress, which has been called for April 11, 1921.

Further publications on the mathematical aspects of this subject may be expected either in the *Transactions of the American Mathematical Society* or in the *American Mathematical Monthly*.

(The manuscript for this article was received by the editor on April 15, 1921.)

where A, B, are the populations of the two states, and a, b, the number of representatives assigned to each.

When we come to translate this proportion into the form of a numerical equation, we find that this can be done in four ways:

$$A/a=B/b; \text{ or } a/A=b/B; \text{ or } A/B=a/b; \text{ or } B/A=b/a;$$

no one of which has any constitutional claim to be preferred over any of the others. The problem is equivalent, therefore, to the problem of how to make all four of these equations as nearly true as possible. We are thus led to the following:

FUNDAMENTAL PRINCIPLE. *In each of the four equations*

$$A/a=B/b,\ a/A=b/B,\ A/B=a/b,\ B/A=b/a,$$

the quantity on the left and the quantity on the right should be as nearly equal as possible.

This fourfold requirement may be expressed in words as follows:

(I*a*) The *number of people per representative* (that is, the size of a congressional district) in state A, and the number of people per representative in state B, should be as nearly equal as possible. ($A/a=B/b$.)

(I*b*) The *fractional share of a representative per inhabitant* in state A, and the fractional share of a representative per inhabitant in state B, should be as nearly equal as possible. ($a/A=b/B$.)

(I*c*) If state A is, say, *twice as populous* as state B, it should have *twice as many representatives*, as nearly as may be. ($A/B=a/b$.)

(I*d*) If state A is, say, *half as populous* as state B, it should have *half as many representatives*, as nearly as may be. ($B/A=b/a$.)

The validity of this fourfold fundamental principle, as far as it goes, can hardly be called in question, since, as we have seen, it is an inevitable consequence of the plain provisions of the Constitution. To make this principle precise, however, it is necessary to decide what meaning shall be attached to the words "nearly equal," and on this point there is the possibility of a difference of opinion.

II. THE PROPER MEANING OF "NEARLY EQUAL"

There are two measures of inequality in common use: (1) the *absolute* difference, as when we say, the temperatures of two rooms differ by 10 degrees; and (2) the *percentage* difference, as when we say, the wages in two cities differ by 10 per cent.

Since we are dealing here with proportions rather than with absolute numbers, we shall adopt the second of these interpretations.

DEFINITION OF INEQUALITY. *By the "inequality" between two quantities, we shall mean their percentage difference.*

For example, the inequality between 2 and 3 is 50 per cent, while the inequality between 100 and 105 is 5 per cent. Hence 100 and 105 are more "nearly equal" than 2 and 3 are.*

Applying this definition to the four cases mentioned in the fundamental principle, we readily see that any "inequality" that may exist will be precisely the same in all four cases; that is, if the quantities of any one pair are as nearly equal as possible, the quantities of each of the other pairs will also be as nearly equal as possible. In other words, on this interpretation of "nearly equal," the four parts of the fundamental principle are merely four different ways of stating one single requirement. (This would not be true on the other interpretation of "nearly equal"; see Appendix I.)

III. PRECISE FORMULATION OF THE PROBLEM

We are now in position to formulate definitely the conditions or postulates which an apportionment ought, if possible, to satisfy.

For the case of two states, we have

POSTULATE I. *For two states, A and B, the percentage difference between A/a and B/b (or between a/A and b/B, or between A/B and a/b, or between B/A and b/a, which all come to the same thing) should be as small as possible.*

For the case of three or more states one further postulate is needed.

POSTULATE II. *In a satisfactory apportionment, there should be no pair of states which is capable of being "improved" by a transfer of representatives within that pair*—the word "improvement" being understood in the sense implied by Postulate I, and the rare case of a "tie" being decided in favor of the larger state.

On the basis of these two simple postulates, the following theorem can now be established:

THEOREM I. *For any given values of A, B, C, . . . and N, there will always be one and only one "satisfactory" apportionment in the sense defined by Postulates I and II.* (See "working rule" below.)

The method thus developed may be called the *Method of Equal Proportions.*

IV. THE METHOD OF EQUAL PROPORTIONS: WORKING RULE

A practical working rule for computing the required apportionment in any given case may be stated as follows:

First, assign one representative to each state (here 48 in number).

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* "Percentage difference" is here thought of as the absolute difference divided by the smaller number. For the present purpose it might equally well be thought of as the absolute difference divided by the larger number, or the absolute difference divided by the mean (arithmetic, geometric, or harmonic) between the two numbers.

Next, multiply the population of each state by as many of the numbers

$$1/\sqrt{1\times 2}, \qquad 1/\sqrt{2\times 3}, \qquad 1/\sqrt{3\times 4}, \quad \cdots$$

as may be necessary, and record each result, together with the name of the state, on a small card. (A table of multipliers is given below.) Then arrange these cards according to the magnitude of the numbers recorded upon them, from the largest to the smallest, thus forming a "priority list" for the given states. Finally, assign further representatives, beginning with the 49th, to the several states in the order in which the names of the states occur in this priority list, until the required total, N, has been reached.

In practice, the multiplications for any state may stop with the last result which is greater than P/N', where P is the total population of all the states, and N' is a number larger than the largest value of N likely to be required.

The proof that this working rule will always give an apportionment satisfying the conditions of Postulates I and II is a straight-forward piece of algebra which need not be given here.

It will be observed that the "multipliers" are the reciprocals of the geometric means of consecutive integers; hence the method of equal proportions may be called also the *method of the geometric mean.**

TABLE I

TABLE OF MULTIPLIERS

k	$1/\sqrt{(k-1)k}$	Diff.	k	$1/\sqrt{(k-1)k}$	Diff.	k	$1/\sqrt{(k-1)k}$	Diff.
1	....	....	18	.057 1662	.003 4677	35	.028 9886	.000 8655
2	.707 1068	....	19	.054 0732	.003 0930	36	.028 1718	.000 8168
3	.408 2483	.298 8585	20	.051 2989	.002 7743	37	.027 3998	.000 7720
4	.288 6751	.119 5732	21	.048 7950 +	.002 5039	38	.026 6690	.000 7308
5	.223 6068	.065 0683	22	.046 5242	.002 2708	39	.025 9762	.000 6928
6	.182 5742	.041 0326	23	.044 4554	.002 0688	40	.025 3185 —	.000 6577
7	.154 3033	.028 2709	24	.042 5628	.001 8926	41	.024 6932	.000 6253
8	.133 6306	.020 6727	25	.040 8248	.001 7380	42	.024 0981	.000 5951
9	.117 8511	.015 7795	26	.039 2232	.001 6016	43	.023 5310	.000 5671
10	.105 4093	.012 4418	27	.037 7426	.001 4806	44	.022 9900	.000 5410
11	.095 3463	.010 0630	28	.036 3696	.001 3730	45	.022 4733	.000 5167
12	.087 0388	.008 3075	29	.035 0931	.001 2765	46	.021 9793	.000 4940
13	.080 0641	.006 9747	30	.033 9032	.001 1899	47	.021 5066	.000 4727
14	.074 1249	.005 9392	31	.032 7913	.001 1119	48	.021 0538	.000 4528
15	.069 0066	.005 1183	32	.031 7500 +	.001 0413	49	.020 6197	.000 4341
16	.064 5497	.004 4569	33	.030 7729	.000 9771	50	.020 2031	.000 4166
17	.060 6339	.003 9158	34	.029 8541	.000 9188	51	.019 8030	.000 4001

---

* This method of equal proportions resembles closely the "method of alternate ratios" proposed by Dr. Joseph A. Hill, chief statistician of the Bureau of the Census, in 1910. (See Appendix II.) In most practical cases Dr. Hill's method will give precisely the same apportionment as the method here proposed; in some cases, however, it can be shown to lead to inconsistent results. To Dr. Hill belongs the credit of being the first to propose and advocate the use of percentage differences in this problem; he also made a partial application of the idea of a priority list based on the geometric mean. In fact, the method of equal proportions, though arrived at through quite independent considerations, is in effect a carrying out to its logical conclusion of the fundamental idea of the method of alternate ratios as proposed by Dr. Hill in 1910. The writer is indebted to Dr. Hill for calling his attention to this problem in the fall of 1920, and for courteous assistance in securing advance figures on population, etc.

V. APPLICATION TO THE 1920 CENSUS

The results of the proposed method of equal proportions as applied to the 1920 census are shown in the accompanying tables. The

TABLE II

TABLES OF APPORTIONMENT (1920) FOR ANY SIZE OF HOUSE FROM 435 TO 484

1910 435	Table for 435			Priority List, showing where each additional member from the 436th to 484th should be assigned	Table for 484		
	State	1920 435	Gain or Loss over 1910		State	1920 484	Gain over 1910
10	Ala.	10		436 N. Y. 43	Ala.	11	1
1	Ariz.	1		437 N. C. 11	Ariz.	1	
7	Ark.	7		438 Va. 10	Ark.	8	1
11	Calif.	14	3	439 La. 8	Calif.	16	5
4	Colo.	4		440 Miss. 8	Colo.	4	
5	Conn.	6	1	441 Tex. 20	Conn.	6	1
1	Del.	1		442 Okla. 9	Del.	1	
4	Fla.	4		443 Pa. 37	Fla.	4	
12	Ga.	12		444 N. Y. 44	Ga.	13	1
2	Idaho	2		445 Mich. 16	Idaho	2	
27	Ill.	27		446 Nebr. 6	Ill.	30	3
13	Ind.	12	—1	447 Kans. 8	Ind.	13	
11*	Iowa	10	—1	448 Calif. 15	Iowa	11	
8	Kans.	7	—1	449 Ill. 28	Kans.	8	
11	Ky.	10	—1	450 Ohio 25	Ky.	11	
8	La.	7	—1	451 Mo. 15	La.	8	
4	Maine	3	—1	452 Ind. 13	Maine	4	
6	Md.	6		453 Ark. 8	Md.	7	1
16	Mass.	16		454 N. J. 14	Mass.	18	2
13	Mich.	15	2	455 Mass. 17	Mich.	17	4
10	Minn.	10		456 N. Y. 45	Minn.	11	1
8	Miss.	7	—1	457 Pa. 38	Miss.	8	
16	Mo.	14	—2	458 Ga. 13	Mo.	16	
2	Mont.	2		459 Ky. 11	Mont.	3	1
6	Nebr.	5	—1	460 Iowa 11	Nebr.	6	
1	Nev.	1		461 Wis. 12	Nev.	1	
2	N. H.	2		462 N. Y. 46	N. H.	2	
12	N. J.	13	1	463 Ill. 29	N. J.	14	2
1*	N. M.	2	1	464 Tex. 21	N. M.	2	1
43	N. Y.	42	—1	465 Minn. 11	N. Y.	47	4
10	N. C.	10		466 Pa. 39	N. C.	12	2
3	N. D.	3		467 Ore. 4	N. D.	3	
22	Ohio	24	2	468 Ohio 26	Ohio	26	4
8	Okla.	8		469 W. Va. 7	Okla.	9	1
3	Ore.	3		470 S. C. 8	Ore.	4	1
36	Pa.	36		471 Ala. 11	Pa.	40	4
3	R. I.	3		472 Md. 7	R. I.	3	
7	S. C.	7		473 N. Y. 47	S. C.	8	1
3	S. D.	3		474 Tenn. 11	S. D.	3	
10	Tenn.	10		475 N. C. 12	Tenn.	11	1
18	Tex.	19	1	476 Mich. 17	Tex.	21	3
2	Utah	2		477 Maine 4	Utah	2	
2	Vt.	2		478 Calif. 16	Vt.	2	
10	Va.	9	—1	479 Mont. 3	Va.	11	1
5	Wash.	6	1	480 Pa. 40	Wash.	6	1
6	W. Va.	6		481 Mass. 18	W. Va.	7	1
11	Wis.	11		482 Va. 11	Wis.	12	1
1	Wyo.	1		483 Ill. 30	Wyo.	1	
				484 Mo. 16			

* If this method had been used in 1910, Iowa would have had 10 and New Mexico 2.

TABLE III

PEOPLE PER REPRESENTATIVE FOR HOUSE OF 435 MEMBERS

1920	No. of Reps.	Congressional District
U. S....	435	241,864
Ala.....	10	234,817
Ariz. ...	1	309,754
Ark.....	7	250,314
Calif....	14	244,716
Colo....	4	234,790
Conn....	6	230,105
Del.....	1	223,003
Fla.....	4	242,118
Ga.	12	241,319
Idaho...	2	215,221
Ill......	27	240,196
Ind.....	12	244,199
Iowa....	10	240,402
Kans....	7	252,751
Ky.	10	241,663
La......	7	256,930
Maine ..	3	256,005
Md.....	6	241,610
Mass....	16	240,772
Mich....	15	244,561
Minn....	10	238,566
Miss....	7	255,803
Mo.....	14	243,147
Mont...	2	270,756
Nebr....	5	259,274
Nev.	1	75,820
N. H....	2	221,542
N. J. ...	13	242,762
N. M. ..	2	176,714
N. Y....	42	247,166
N. .C. ..	10	255,912
N. D....	3	214,915
Ohio....	24	239,975
Okla....	8	253,535
Ore.....	3	261,130
Pa......	36	242,223
R. I. ...	3	201,466
S. C. ...	7	240,532
S. D....	3	210,413
Tenn. ..	10	233,789
Tex.....	19	245,433
Utah....	2	224,194
Vt......	2	176,214
Va......	9	256,576
Wash. ..	6	225,766
W. Va...	6	243,950
Wis.....	11	239,210
Wyo....	1	193,487

rapidity of the method can be judged from the fact that these results can be recomputed (with the aid of Barlow's Tables of square roots and reciprocals and a calculating machine) in less than three hours.

The inequalities which remain between the several states, as indicated, for example, by the varying size of the congressional district,

TABLE IV

POPULATION DATA, 1920

State	Total population 1920	Indians not taxed	Population basis of apportionment
Ala.	2,348,174	......	2,348,174
Ariz.	334,162	24,408	309,754
Ark.	1,752,204	......	1,752,204
Calif.	3,426,861	830	3,426,031
Colo.	939,629	468	939,161
Conn.	1,380,631	......	1,380,631
Del.	223,003	......	223,003
Fla.	968,470	......	968,470
Ga.	2,895,832	......	2,895,832
Idaho	431,866	1,424	430,442
Ill.	6,485,280	......	6,485,280
Ind.	2,930,390	......	2,930,390
Iowa	2,404,021	......	2,404,021
Kans.	1,769,257	......	1,769,257
Ky.	2,416,630	......	2,416,630
La.	1,798,509	......	1,798,509
Maine	768,014	......	768,014
Md.	1,449,661	......	1,449,661
Mass.	3,852,356	......	3,852,356
Mich.	3,668,412	......	3,668,412
Minn.	2,387,125	1,469	2,385,656
Miss.	1,790,618	......	1,790,618
Mo.	3,404,055	......	3,404,055
Mont.	548,889	7,378	541,511
Nebr.	1,296,372	......	1,296,372
Nev.	77,407	1,587	75,820
N. H.	443,083	......	443,083
N. J.	3,155,900	......	3,155,900
N. M.	360,350	6,922	353,428
N. Y.	10,385,227	4,240	10,380,987
N. C.	2,559,123	......	2,559,123
N. D.	646,872	2,126	644,746
Ohio	5,759,394	......	5,759,394
Okla.	2,028,283	......	2,028,283
Ore.	783,389	......	783,389
Pa.	8,720,017	......	8,720,017
R. I.	604,397	......	604,397
S. C.	1,683,724	......	1,683,724
S. D.	636,547	5,308	631,239
Tenn.	2,337,885	......	2,337,885
Tex.	4,663,228	......	4,663,228
Utah	449,396	1,008	448,388
Vt.	352,428	......	352,428
Va.	2,309,187	......	2,309,187
Wash.	1,356,621	2,025	1,354,596
W. Va.	1,463,701	......	1,463,701
Wis.	2,632,067	762	2,631,305
Wyo.	194,402	915	193,487
Total	105,273,049	60,870	105,212,179
D. C.	437,571	......	....
Total	105,710,620	......	....

TABLE V

DETAILS OF THE COMPUTATION REQUIRED IN THE APPLICATION OF THE PROPOSED METHOD TO THE 1920 APPORTIONMENT

Condensed Priority List for Indices Above 244,500

1920		
Ariz.	1	......
Del.	1	......
Wyo.	1	......
Nev.	1	......
Mont.	2	382,906
Ore.	3	319,817
Utah	2	317,058
Maine	3	313,540
N. H.	2	313,307
Idaho	2	304,368
Nebr.	5	289,878
Fla.	4	279,573
La.	7	277,516
Miss.	7	276,298
Kans.	7	273,002
Va.	9	272,140
Colo.	4	271,112
Okla.	8	271,041
Ark.	7	270,371
N. C.	10	269,755
W. Va.	6	267,244
Md.	6	264,671
N. D.	3	263,216
S. C.	7	259,804
S. D.	3	257,702
Ind.	12	255,058
Ky.	10	254,735
Calif.	14	253,954
Iowa	10	253,406
Mich.	15	253,144
N. J.	13	252,674
Mo.	14	252,325
Tex.	19	252,156
Conn.	6	252,068
Ga.	12	252,050
Minn.	10	251,470
Wis.	11	250,885
N. Y.	42	250,162
N. M.	2	249,911
Vt.	2	249,204
Mass.	16	248,669
Ala.	10	247,519
Wash.	6	247,314
R. I.	3	246,744
Tenn.	10	246,435
Pa.	36	245,659
Ohio	24	245,136
Ill.	27	244,771

Complete Priority List for Indices Between 244,500 and 219,000

436	N. Y.	43	244,275
437	N. C.	11	244,003
438	Va.	10	243,410
439	La.	8	240,336
440	Miss.	8	239,281
441	Tex.	20	239,219
442	Okla.	9	239,035
443	Pa.	37	238,927
444	N. Y.	44	238,659
445	Mich.	16	236,795
446	Nebr.	6	236,684
447	Kans.	8	236,427
448	Calif.	15	236,419
449	Ill.	28	235,867
450	Ohio	25	235,126
451	Mo.	15	234,902
452	Ind.	13	234,619
453	Ark.	8	234,148
454	N. J.	14	233,931
455	Mass.	17	233,583
456	N. Y.	45	233,295
457	Pa.	38	232,554
458	Ga.	13	231,852
459	Ky.	11	230,417
460	Iowa	11	229,214
461	Wis.	12	229,026
462	N. Y.	46	228,167
463	Ill.	29	227,589
464	Tex.	21	227,542
465	Minn.	11	227,463
466	Pa.	39	226,513
467	Ore.	4	226,145
468	Ohio	26	225,902
469	W. Va.	7	225,854
470	S. C.	8	224,997
471	Ala.	11	223,890
472	Md.	7	223,688
473	N. Y.	47	223,260
474	Tenn.	11	222,909
475	N. C.	12	222,743
476	Mich.	17	222,430
477	Maine	4	221,707
478	Calif.	16	221,149
479	Mont.	3	221,071
480	Pa.	40	220,778
481	Mass.	18	220,225
482	Va.	11	220,172
483	Ill.	30	219,872
484	Mo.	16	219,731
485	Ariz.	2	219,029

are unavoidable inequalities. Any attempt to reduce the inequality between any two states by transferring a representative from one state to the other will be found to result in increasing that inequality instead of reducing it.

VI. A MEASURE OF TOTAL OR AVERAGE ERROR

The method of equal proportions, as developed above, provides a complete solution of the problem of finding the *best* apportionment for any given values of A, B, C, . . . and N; but it does not provide any measure of comparison between two apportionments which are less good than the best; nor any measure of comparison between two apportionments involving different values of N.

Although such a measure of error is of little or no importance in practice, it may be of interest to note that a satisfactory measure, E, can be supplied as follows:*

Let a be the actual and $\alpha=(A/P)N$ the theoretical number of representatives assigned to a typical state A. Then

$$e=\frac{(a/A)-(\alpha/A)}{\sqrt{(a/A)(\alpha/A)}}=\frac{(A/\alpha)-(A/a)}{\sqrt{(A/\alpha)(A/a)}}=\frac{a-\alpha}{\sqrt{a\alpha}}$$

may be regarded as expressing the *error affecting an individual citizen* of that state. Taking the sum of the squares of all such errors for all the inhabitants of the country, we have as the *total error*

$$T=A\,\frac{(a-\alpha)^2}{a\alpha}+B\,\frac{(b-\beta)^2}{b\beta}+\;.\;\;.\;\;.;$$

whence, dividing by the total population, P, and taking the square root, we have

$$E=\sqrt{T/P}$$

as the *average error* of the whole apportionment. For the purpose of computation, it is convenient to write E in the form:

$$E=\sqrt{T'/N},\text{ where } T'=(a-\alpha)^2/a+(b-\beta)^2/b+\;.\;\;.\;\;.$$

It can be shown that in any given case the method which makes the value of this total or average error a minimum, is precisely the method of equal proportions.

---

* The expression E for the average error is new, and is to be presented to the American Mathematical Society on April 23, 1921. An earlier but less satisfactory expression was proposed by Professor F. W. Owens on February 26, 1921 (see Appendix II).

APPENDIX I

CRITICISM OF FOUR ALTERNATIVE METHODS BASED ON A WRONG INTERPRETATION OF "NEARLY EQUAL"

If the inequality between two quantities were to be measured by their *absolute difference*, instead of by their percentage difference, the four parts of our fundamental principle would lead to four distinct and conflicting methods of apportionment, which may be called Methods I*a*, I*b*, I*c*, I*d*. Since there is no mathematical ground for choosing between I*a* and I*b*, or between I*c* and I*d*, the result would be a hopeless dilemma, which shows conclusively that the "absolute difference" interpretation is not the interpretation that is appropriate to the present problem.

In contrast with these four conflicting methods, the method of equal proportions, which may be called Method I, involves no such dilemma, since it satisfies all four of the requirements of the fundamental principle simultaneously.

The following notes on Methods I*a*, I*b*, I*c*, I*d* may be of interest.

Method I*a* leads to a "working rule" with the following "multipliers":

$$\frac{1+2}{2(1\times2)},\quad \frac{2+3}{2(2\times3)},\quad \frac{3+4}{2(3\times4)},\quad \frac{4+5}{2(4\times5)},\quad \ldots$$

and may therefore be called the *method of the harmonic mean.* This method, whenever it differs from Method I, favors the small states more than Method I does. (See Example 1*a* and Example 1.)

Method I*b*, taken in connection with the requirement that every state shall have at least one representative, leads to a "working rule" with the following "multipliers":

$$2/3,\quad 2/5,\quad 2/7,\quad 2/9,\quad \ldots$$

and may therefore be called the *method of the arithmetic mean.* This method, whenever it differs from Method I, favors the large states more than Method I does. (See Example 1*b* and Example 1.)*

The amount by which the results of Methods I*a* and I*b* may diverge is often large, as illustrated in Examples 2, 2*a*, and 2*b*.

Methods I*c* and I*d* also determine two distinct methods (for which no "working rules" have been devised). It can be shown that I*c* favors the small states even more than I*a* does, while I*d* favors the large states even more than I*b* does. (See Examples 1*c* and 1*d*, and Example 1.)

---

* The working rule for Method I*b* was first employed by Professor W. F. Willcox in 1910, as the basis of his "method of major fractions" (see Appendix II). The existence of the correlative Method I*a* was not known at that time.

All four of these conflicting methods should therefore be rejected in favor of Method I, which satisfies all four parts of our fundamental principle simultaneously.

APPENDIX II

CRITICISM OF OTHER METHODS OF APPORTIONMENT*

1. *The Vinton Method of 1850.* In this method, long in use in Congress, the rule of procedure is as follows:

First, compute the exact quota for each state, putting aside for separate consideration those states whose quotas are less than one. Next, assign to each of the remaining states a number of representatives equal to the largest whole number contained in the exact quota for that state, and add the results. Then ascertain, by subtraction, how many additional representatives must be assigned "for fractions." Finally, as-

Example 1a

	Ia	I Ib
A 454	4	5
B 246	3	2
700	7	7

Example 1b

	I Ia	Ib
A 451	4	5
B 249	3	2
700	7	7

Example 1c

	Ic	I, Ia Ib, Id
A 564	5	6
B 136	2	1
700	7	7

Example 1d

	I, Ia Ib, Ic	Id
A 548	5	6
B 152	2	1
700	7	7

Example 1

	Ic	Ia	I	Ib	Id
A 564	5	6	6	6	6
B 548	5	5	5	5	6
C 454	4	4	5	5	5
D 451	4	4	4	5	5
E 249	3	3	3	2	2
F 246	3	3	2	2	2
G 152	2	2	2	2	1
H 136	2	1	1	1	1
2800	28	28	28	28	28

Example 2a

	Ia	I	Ib
A 9420	92	93	96
B 147	2	2	1
C 146	2	2	1
D 144	2	2	1
E 143	2	1	1
10000	100	100	100

Example 2

	Ia	I	Ib
A 9430	92	94	96
B 144	2	2	1
C 143	2	2	1
D 142	2	1	1
E 141	2	1	1
10000	100	100	100

Example 2b

	Ia	I	Ib
A 9440	92	95	96
B 143	2	2	1
C 140	2	1	1
D 139	2	1	1
E 138	2	1	1
10000	100	100	100

---

* On the Vinton, Hill, and Willcox methods, see papers by J. A. Hill and W. F. Willcox in *House of Representatives Report No. 12*, pp. 1–108, of the Sixty-second Congress, First Session, April 25, 1911; also the presidential address of W. F. Willcox, read at the annual meeting of the American Economic Association, December, 1915, and published in the *American Economic Review*, vol. 6, no. 1, Supplement, pp. 1–16, March, 1916. Tables for the 1920 apportionment according to the Willcox method are printed in *House of Representatives Report* No. 1173, pp. 1–28, of the Sixty-Sixth Congress, Third Session, January 8, 1921. On the d'Hondt method, see John H. Humphreys, *Proportional Representation*, London, 1911, pp. 178–180 and 188–190. On the Owens theory of the Willcox method, nothing has yet been published (April 1, 1921).

In this method, the population of each state (or political party) is divided by as many of the numbers 1, 2, 3, 4, . . . as may be necessary, and all the results are then arranged in a priority list in order of magnitude. The representatives, beginning with the first, are then assigned to the several states in the order in which the names of the states occur in this priority list.

In this plan, some states may receive several representatives before other states receive any, so that in order to meet the United States requirement that every state shall have at least one representative, the rule would have to be modified by changing "beginning with the first" to "beginning with the 49th." With or without this modification, the method favors the larger states more than does any other known method, as illustrated in Example 5.

This method therefore violates all four parts of our fundamental principle, no matter which interpretation of "nearly equal" is adopted.

5. *The Owens method of least error* (so-called), which was proposed by Professor F. W. Owens of Cornell University at a recent meeting of the American Mathematical Society, February 26, 1921, is not a new method of apportionment, but a new mathematical basis for the Willcox method of major fractions.

Professor Owens, having in mind the theory of Least Squares, starts with a selected expression for the "total error" of an apportionment, namely:

$$Q=A[(a/A)-k]^2+B[(b/B)-k]^2+C[(c/C)-k]^2+ \quad . \quad . \quad . \quad ,$$

and then shows that the method which minimizes this total error Q is precisely the Willcox method.

Here k denotes the true value of a/A or b/B or c/C, . . . It may be noted, however, that any other value of k, even $k=0$, might be substituted without affecting the final result.

In the opinion of the present writer, there is no sufficient reason for selecting the fraction a/A rather than the fraction A/a, or for selecting the absolute difference rather than the percentage difference, in building up the expression for Q. If one must use the idea of total error (which is not required in the method of equal proportions), a better expression for it would be the value T given in a previous paragraph.

In any case, the failure of the Willcox method to meet most of the requirements of our fundamental principle is not in any way affected by the Owens theory. That fundamental principle is an inevitable consequence of the plain provisions of the Constitution, with nothing read between the lines; and the only method which can satisfy the whole of that principle is the method of equal proportions.

EFFECT ON THE RESERVE RATIO OF CHANGES IN RESERVES AND IN LIABILITIES

By E. A. Goldenweiser, *Federal Reserve Board*

With the growing importance of the reserve ratio of Federal Reserve banks as an indicator of the credit condition of the country, it has become of interest to study in detail the various elements that have an effect on that ratio. In this paper no reference is made to the economic and financial conditions affecting the reserve position of the Federal Reserve banks, but an effort is made to determine the effect on the reserve ratio of changes in reserves and in liabilities.

In order to make this discussion understandable to persons not familiar with Federal Reserve banking, it may be stated that the reserve ratio of the Federal Reserve banks is calculated by dividing total cash reserves by combined liabilities on deposits and on Federal Reserve notes. The formula is as follows: $\text{Reserve ratio} = \frac{\text{Cash reserves}}{\text{Deposits} + \text{Notes}}$. It is clear, therefore, that the reserve ratio increases as cash reserves increase, and decreases as liabilities increase, and vice versa.

The problem was brought prominently to the attention of the Federal Reserve Board by the large increase in reserves in recent months (owing to the inward gold movement) accompanied by continuous declines in liabilities. The reserve ratio stood at the end of May at above 57 per cent, as compared with a low ratio of 42 per cent about a year ago. It has been a matter of interest and of importance to determine to what extent this increase in the reserve ratio has been caused by additions to reserves, and to what extent by reductions of liabilities.

One way of studying the matter is by a comparison of two given dates, and another way is by an analysis of continuous changes for a given period. Each of these methods lends itself to study in a rough approximate way, but each can also be approached with a view to reducing it to an exact mathematical formula or index. The various methods that have been followed will be briefly described in the discussion below.

COMPARISON FOR TWO GIVEN DATES

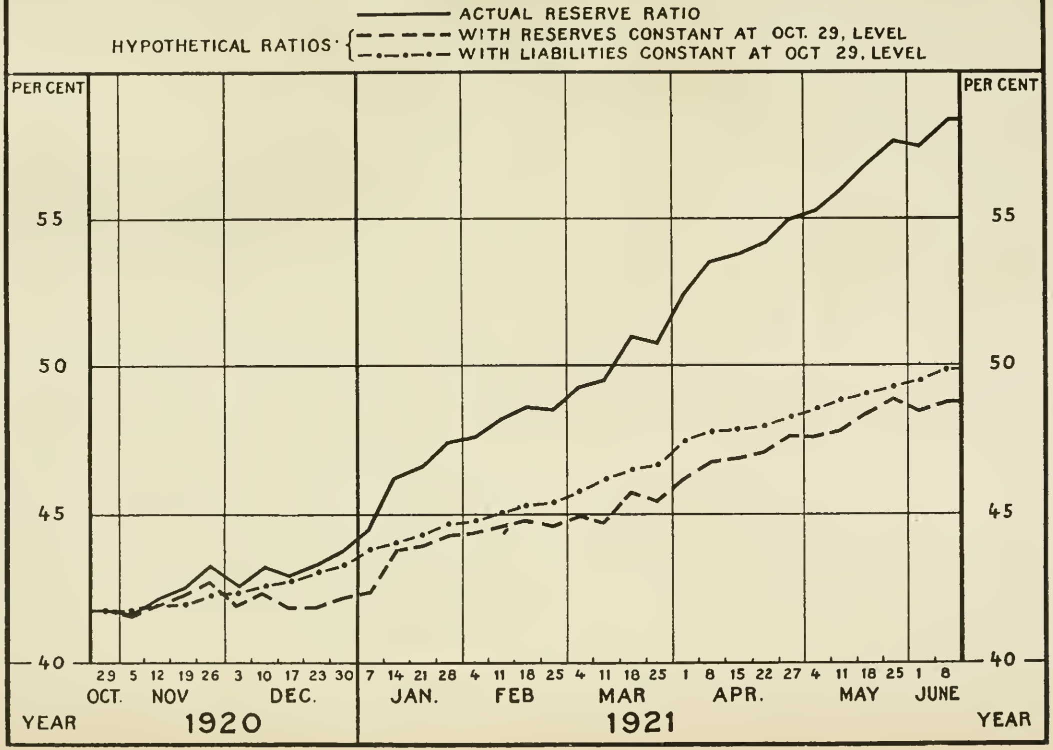
Selecting for the purpose of this discussion the end of October, 1920, and the end of May, 1921, as the boundaries of the period to be studied, we find the pertinent facts to have been as follows: At the end of October, 1920, the banks' cash reserves were $2,168,038,000, total deposits, $1,845,722,000, and Federal Reserve note circulation, $3,351,303,000, resulting in a reserve percentage of 41.7. By June 1, 1921, these figures had changed in the following manner: Reserves had increased by $400,787,000, or 18.5 per cent, deposits had declined by $125,332,000, and notes, by $600,004,000, the aggregate decline in liabilities being $725,336,000, or 13.96 per cent. The reserve ratio on the latter date was 57.4 per cent. A rough way of estimating the effect of the two factors, or of the three factors, on the reserve ratio is by assuming consecutively that each of the factors had remained unchanged, and comparing the resultant reserve ratios with the actual reserve ratio. In the present case it would work out as follows: If reserves had remained stationary at the end-of-October figure of $2,168,038,000, the reserve ratio on June 1 would have been 48.5 per cent. If note circulation had remained stationary, the percentage would have been 50.6 per cent; if deposit liabilities had remained unchanged, it would have been 55.9 per cent; if no change had taken place in either class of liabilities, or if the changes had been mutually compensatory, the ratio would have been 49.4 per cent. The situation can be summarized as follows:

	Per cent
Actual ratio on June 1, 1921	57.4
Hypothetical ratio, with the specified items unchanged at October 29, 1920, level:	
Reserves	48.5
Total liabilities	49.4
Deposits	55.9
Notes	50.6

From these figures it appears that changes in reserves were the largest factor in the increase of the reserve ratio between October 29 and June 1, as the retention of the reserves at their October level would have caused the greatest departure from the ratio actually shown for June 1. But reduction in liabilities was nearly as powerful a factor, while of the two kinds of liabilities, notes in circulation affected the ratio a great deal more than deposits, which have changed comparatively little since October.

This method gives a general impression of the changes that took place between the two terminal dates, but an effort was made also to obtain a formula that would distribute the increase in the reserve ratio between the factors involved with mathematical accuracy. Such an algebraic formula was worked out by Mr. J. R. Van Fossen of the Board's staff. He assumed that *A* equals the percentage increase in reserves and *B* the percentage increase in combined Federal Reserve

MOVEMENT OF RESERVE RATIO



note and deposit liabilities. Since the reserve ratio varies directly as reserves and inversely as combined note and deposit liabilities, A will represent also the percentage increase in the reserve ratio, when liabilities remain constant, while $\frac{1}{1+B}-1$ will represent the percentage increase in reserve ratio when reserves remain constant and liabilities alone vary. When both reserves and combined liability vary, the percentage change in the resulting reserve ratio will be caused by the two factors in the ratio of A to $\left(\frac{1}{1+B}-1\right)$ or $\left(\frac{-B}{1+B}\right)$. Accordingly, the effect attributable to the change in reserves is given by the expression $\frac{A}{A+\left(\frac{-B}{1+B}\right)}$ times the percentage increase in the reserve ratio, while that of the liabilities is given by the expression $\frac{\frac{-B}{1+B}}{A+\left(\frac{-B}{1+B}\right)}$ times the percentage increase in the reserve ratio (R) Simplifying these expressions we obtain $R\left(\frac{A+AB}{A+AB-B}\right)$ and $R\left(\frac{-B}{A+AB-B}\right)$.

This formula works out satisfactorily the apportionment of changes in the reserve ratio as long as both of the factors affect the ratio in the same direction, *i. e.*, as long as they move in opposite directions. When, however, reserves and liabilities both increase or both decrease, the formula gives illogical results because of technical mathematical reasons having to do with apportionment of a quantity in proportion to negative and positive factors and with the disturbing appearance of zero in the equation at the point where the two opposite changes exactly offset each other. For this reason it is not possible to use this formula in cases in which reserves have increased and liabilities have also increased. To meet this situation, which apparently does not lend itself to accurate mathematical determination, a method of approximation has been devised. To take a concrete though purely hypothetical example: Suppose that cash reserves equaled 100 and liabilities 200, then the ratio would be $\frac{100}{200}$, or 50 per cent. Suppose that reserves increased by 50 per cent to 150 and liabilities by 12½ per cent to 225, then the ratio would be $\frac{150}{225}=66⅔$ per cent, an increase in ratio from 50 to 66⅔ per cent, or (on the basis of 50 as 100) an increase of 33⅓ per cent. The problem is: What are the two factors, one positive and one negative, that have resulted in the 33⅓ per cent increase in reserves? The 50 per cent increase in reserves, with liabilities constant, would have caused a 50 per cent increase in ratio; the 12.5 per cent increase in liabilities, with reserves constant, would have caused a 11.3 per cent decrease in the ratio; and the result of the two factors operating independently would have been an increase of 50 per cent and a decrease of 11 per cent, giving an ultimate increase of 39 per cent. But the actual increase was only 33 per cent. Distribute the difference $(39-33=6)$ in proportion to the "motive power" of the changes in reserves and in liabilities, namely 50 and 11, or roughly 5 to 1. The increase due to the reserves will thus not be 50 per cent, but only 45 per cent, and the decrease due to increase in liabilities will not be 11 per cent, but 12 per cent. Answer: the increase of 33 per cent in ratio is attributable roughly to an increase of 45 per cent due to the increase in reserves, offset in part by a decrease of 12 per cent caused by the increase in liabilities. This method, although not absolutely accurate, affords a sufficiently close approximation to accuracy to answer all practical requirements.

The apportionment between notes and deposits of the increase or decrease in ratio attributable to the change in liabilities is a simple problem in proportion. The division must be in proportion to the effect that the change in each factor has had on the combined liabilities. Further details on this simple point do not appear to be necessary in this discussion.

CONTINUOUS COMPARISONS FOR A PERIOD OF TIME

As against the above methods of comparing two separate dates, there have been made also studies of the week-to-week relationship between the changes in reserves and in liabilities. Here again a crude general study may be made by assuming that each factor in turn remained constant, and in seeing how the result in the reserve ratio would vary from the actual reserve ratio. The accompanying chart is based on figures computed on these assumptions. It shows that on the whole changes in reserves and in liabilities have been of approximately equal importance in causing changes in the reserve ratio during the period under discussion, although the changes in reserves have been slightly more potent than changes in liabilities, as evidenced by the fact that the curve showing the ratio with reserves constant is almost continuously lower than the curve showing the ratio with liabilities constant.

However, a more accurate way of determining these relationships was thought desirable, and a coefficient of correlation was worked out. But the results were unsatisfactory, mainly because the coefficient of correlation in its derivation assumes a norm or base and works from that base. The Pearson coefficient originated in biological study where a norm is assumed to exist. In banking statistics during a period of rapid change without much historic precedent, there is no norm, and a correlation worked out in relation to an arbitrary amount for a given date or to a short-time average is not a satisfactory method of procedure. For this reason it was decided to compare the changes from week to week, using each successive week as a base for the change for the following week. In this manner an index of divergence was worked out. In developing the index, the successive steps may be described as follows:

1. The actual amounts of each of the five items involved (reserves, notes, deposits, combined liabilities, and ratio) were listed in millions of dollars for each week from October 29, 1920, to June 1, 1921.

2. For each of the items, the increases or decreases from one week to the next in absolute amounts were written in a second column.

3. The percentages of increase or decrease for each week were calculated.

4. For each set of quantities the divergence between the percentage of change from week to week was figured.

5. These divergences were added and then divided by the number of weeks; the quotient is "the index of divergence."

Of the various steps in the procedure, only the fourth calls for discussion, the others being plain arithmetical propositions.

In the following table the absolute amounts are omitted in order to save space and also because they have no bearing on the method; only the percentages and the divergences are shown. In order to understand the method, it should be borne in mind that what is done is to compare the four sets of relationships:

(*a*) Between changes in the reserve ratio and in cash reserves.

(*b*) Between changes in the reserve ratio and in deposit and note liabilities combined.

(*c*) Between changes in the reserve ratio and in Federal Reserve notes.

(*d*) Between changes in the reserve ratio and in net deposits.

To begin with the first relationship:

During the week ending November 5, cash reserves increased by 0.08 per cent. During the same week, the reserve ratio decreased by 0.10 per cent. The relationship between cash reserves and the reserve ratio being direct, a decline in cash reserves—other things being equal—would result in a proportionate decline in the ratio. The divergence, therefore, equals the sum of the percentage of increase in

Week ending—	Percentage of increase (+) or of decrease (—) in					Divergence in percentage changes in reserve ratio and—			
	Cash reserves	Federal Reserve notes	Total deposits	Notes and deposits combined	Reserve ratio	Cash reserves	Federal Reserve notes	Total deposits	Notes and deposits combined
1920									
October 29	+ .50	— .15	+1.59	+ .47	+ .02	.48	.13	1.61	.49
November 5	+ .08	+ .09	+ .32	+ .17	— .10	.18	.01	.22	.07
12	+ .47	— .75	— .33	— .60	+1.06	.59	.31	.73	.46
19	+ .01	— .65	—1.36	— .90	+ .95	.94	.30	.41	.05
26	+ .69	+ .55	—3.83	—1.01	+1.72	1.03	2.27	2.11	.71
December 3	+ .13	— .41	+5.69	+1.70	—1.55	1.68	1.96	4.14	.15
10	+ .65	— .01	—2.07	— .75	+1.41	.76	1.40	.66	.66
17	+ .45	+ .98	+1.03	+1.00	— .53	.98	.45	.50	.47
23	+ .64	+1.81	—3.24	+ .02	+ .61	.03	2.42	2.63	.63
30	+ .55	—1.77	+1.56	— .63	+1.20	.65	.57	2.76	.57
1921									
January 7	+1.23	—2.23	+2.67	— .52	+1.76	.53	.47	4.43	1.24
14	+ .51	—3.38	—2.93	—3.22	+3.84	3.33	.46	.91	.62
21	+ .55	—1.40	+1.69	— .28	+ .84	.29	.56	2.53	.56
28	+ .81	— .79	— .82	— .80	+1.63	.82	.84	.81	.83
February 4	+ .27	— .49	+ .52	— .12	+ .38	.11	.11	.90	.26
11	+ .69	— .82	— .16	— .58	+1.26	.57	.44	1.10	.68
18	+ .46	— .43	— .42	— .42	+ .89	.43	.46	.47	.47
25	+ .17	+ .47	+ .12	+ .34	— .15	.32	.32	.03	.19
March 4	+ .80	— .30	—1.26	— .66	+1.46	66	1.16	.20	.80
11	+ .93	—1.21	+3.21	+ .43	+ .51	.42	.70	3.72	.94
18	+ .70	—1.43	—3.75	—2.31	+3.07	2.37	1.64	.68	.76
25	+ .30	—1.09	+3.73	+ .72	— .41	.71	1.50	3.32	.31
April 1	+1.62	— .77	—2.81	—1.56	+3.23	1.61	2.46	.42	1.67
8	+ .84	— .49	—2.45	—1.24	+2.10	1.26	1.61	.35	.86
15	+ .13	— .88	+ .55	— .34	+ .47	.34	.41	1.02	.13
22	+ .31	— .41	— .32	— .38	+ .69	.38	.28	.37	.31
27	+ .48	— .93	— .13	—1.09	+1.59	1.11	.66	1.46	.50
May 4	+ .60	— .05	+ .18	+ .03	+ .56	.04	.51	.74	.59
11	+ .71	— .84	+ .26	— .42	+1.14	.43	.30	1.40	.72
18	+ .45	—1.34	— .97	—1.20	+1.66	1.21	.32	.69	.46
25	+ .36	—1.18	— .62	— .97	+1.34	.98	.16	.72	.37
June 1	+ .41	+ .60	+ .85	+ .70	— .28	.69	.32	.57	.42
Total divergence						25.93	25.51	42.61	17.95
Index of divergence						.81	.80	1.33	.56

cash reserves and the percentage of decrease in the reserve ratio, that is, 0.08+0.10=0.18. The same calculation is made for each week of the period. These divergences are then added, totaling 25.45, which, when divided by the number of weeks, gives an index of divergence of 0.82.

In measuring the relationship between the reserve ratio and the liabilities, either separately or combined, the method of procedure is modified by the fact that the relationship is inverse. For example, taking the same week as above, Federal Reserve notes and deposits combined show an increase of 0.17 per cent. During the same week, the reserve ratio shows a decrease of 0.10 per cent. The difference between these declines is 0.07. The same calculation for each week of the period, when averaged, gives an index of divergence of 0.56.

The method used in the calculation of the index of divergence of Federal Reserve notes and total deposits is exactly the same as that used in the calculation of the two combined. The indices of divergence are 0.80 for Federal Reserve notes and 1.33 for total deposits. In view of the fact that Federal Reserve notes and total deposits are each only part of the divisor in calculating the ratio, it is to be expected that the divergence would be greater in the case of those partial factors than in the case of total cash reserves or of total liabilities. It will be noted, however, that the index of divergence for Federal Reserve notes is no larger than that for cash reserves. This means that in spite of the handicap of being only a partial factor, Federal Reserve notes have, as a matter of fact, fluctuated in as close harmony with the reserve ratio as have cash reserves. On the other hand, total deposits show an index of divergence that is much greater than that of any of the other factors involved.

It is admitted that this method is crude. A much more refined way of arriving at the result has been worked out by G. P. Watkins in a paper to be published later. Watkins works with logarithms instead of percentages, because logarithms can be added, subtracted, and divided without damage to their correctness, whereas percentages are not adapted to that use for accurate purposes for the reason that an increase of 10 per cent does not correspond to a decrease of 10 per cent, but to one of 9 per cent. Watkins, who attacked the problem in connection with a study of grain prices, also makes corrections for variability and trend, and his results are of a high order of mathematical accuracy. For the purposes of the Federal Reserve Board, however, it is probable that the index of divergence, as described in this paper, is sufficiently accurate to indicate the relative closeness of variations in the reserve ratio and in reserves, on the one hand, and in notes and deposits on the other.

ELECTRICAL STATISTICS AS A BAROMETER OF INDUSTRIAL ACTIVITY

By Robert M. Davis, *Statistical Editor, Electrical World*

Grimm's tale of the boy who possessed the seven-league boots is fully exemplified in the phenomenal growth of the electric light and power industry, which has developed by leaps and bounds and has become one of the fundamental elements of America's industrial fabric. There is probably no primary industry that can show such rapid statistical growth. Certainly none can show a more enthusiastic adoption by the American people, both in the home and in the factory.

During the past six years the yearly output of the central generating stations of the country has increased from 16,782,000,000 kilowatt-hours in 1914 to 45,678,000,000 kilowatt-hours in 1920, or 173 per cent. During the same period the annual gross revenue increased from $336,980,000 to $882,750,000, or 162 per cent. The installed rating of the central generating plants has increased from 7,000,000 kilowatts in 1914 to 13,750,000 kilowatts on January 1, 1921, and during the same period the capital invested in the light and power industry has increased from $2,706,000,000 to $4,050,000,000.

These figures point to several pertinent conclusions, but above all they show clearly that electrical energy has fused itself into the very heart of American life; that it is no longer an experiment or a luxury, but a power controlling, and so reflecting, both the domestic and the industrial life of our country. In a section of the country that today has poor electric facilities one unfailingly finds a community practically without industrial life, except possibly agriculture or mining; and as a rule the inhabitants of that region are either nomads or are living far below the average scale to be found in the remaining portions of the United States.

The production of electrical energy by the central generating plants of the country depends upon two separate and distinct elements, the domestic and municipal lighting load, and the industrial or manufacturing load. The lighting load varies with the season, increasing materially in the fall and winter and decreasing as the winter wanes and the long summer days approach. The industrial demand for electrical energy, on the other hand, depends solely upon the rate of operations in the various industries. A slack season during which only a portion of the machinery is placed in operation results in a call for less electrical energy for power purposes, while a season of intense industrial activity may result in a power demand far in excess of the power companies' capacity to fulfil. Every American industry has now adopted electrical energy as a source of power to such an extent that the least depression in any primary industry in any section of the country is at once reflected in the operation of the central generating plants that furnish electrical energy to that section. As time passes and industry is more and more electrified, the reports of central station operations will more fully reflect industrial activity. But to the trained statistician, ready to read between the lines and to notice the least variance in the operation of the light and power industry, it is now possible to interpret central station monthly returns in such detail that with a general knowledge of industrial affairs the extent of productive curtailment in any industry can be readily ascertained. Such interpretation may be made for a certain city or community, based upon the detail returns of one or more of the electric light and power companies serving that community. Or industrial conditions in a large section of the country may be clearly defined by a study of group operation figures from a large percentage of the light and power companies of that section. And, finally, the general tone of industrial America is pictured in an unmistakable manner by the tabulation of the monthly operations of a large percentage of the light and power companies of the country.

Let us study briefly the output figures of the central generating and distributing companies of the country for the month of March, 1921, as received by the Statistical Department of the *Electrical World*. Reports are received from companies representing 78 per cent of the installed rating of the central generating plants of the country; the 22 per cent not making returns are small plants located for the most part in purely agricultural regions. Reports are received monthly for electrical output, gross revenue, and operating and maintenance expenses. The story which the gross revenue and operating expenses tells is a very important one to the light and power industry, but it has little bearing on the subject under consideration.

Table I gives the aggregate central station returns for the twelve month period ending with March, 1921. Table II gives similar figures for the same period, but by the five sections of the country. The diagram shows the electric light and power operations for the past three years.

Returns of central station operations received by the *Electrical World* for the month of March, as shown in these tables, clearly indicated a resumption of industrial activity in every section of the country. In spite of the rapidly advancing season and the correspondingly decreased lighting requirements, the average daily output was 100,000 kilowatt-hours in excess of that reported for January, and 2,200,000 kilowatt-hours in excess of the February output. The estimated output during March of 3,648,000,000 kilowatt-hours was, however, 8 per cent below that of March, 1920; but it must be remembered that the spring of last year saw some of the most intense industrial activity in the history of the nation.

TABLE I

CENTRAL-STATION RETURNS FOR TWELVE MONTHS

	Percentage of installed ratings represented	Kw.-hr. output (companies reporting)			Percentage of installed ratings represented	Revenue from the sale of energy (companies reporting)		
		1920 Thousands	1919 Thousands	Per cent increase		1920 Thousands	1919 Thousands	Per cent increase
April........	70	2,603,692	2,098,559	24.1	65	$45,547	$36,541	24.5
May........	70	2,631,560	2,179,916	21.2	65	43,888	35,512	23.4
June........	71	2,630,831	2,175,645	20.2	66	44,434	35,528	24.5
July........	71	2,677,131	2,234,215	20.0	66	46,608	36,265	28.5
Aug.........	71	2,769,175	2,303,099	20.1	66	47,410	36,713	29.1
Sept.........	71	2,734,179	2,327,460	17.4	66	49,224	38,209	28.5
Oct.	71	2,797,625	2,499,488	11.9	66	51,370	41,055	25.1
Nov.........	71	2,741,705	2,503,402	9.6	66	54,620	44,711	22.0
Dec.........	71	2,792,554	2,648,746	5.4	66	57,697	48,580	18.6
		1921	1920			1921	1920	
Jan..........	76	2,765,632	2,943,349	—6.0	70	58,855	50,861	15.8
Feb.........	76	2,456,553	2,711,251	—9.4	70	55,778	48,624	14.8
Mar.........	77	2,812,493	3,179,943	—11.6	72	55,706	49,014	13.7

	Percentage of installed ratings represented	Operating and maintenance expenses (companies reporting)			Operating Ratio					
					Steam plants		Hydro plants		Combined systems of steam and hydro	
		1921 Thousands of dollars	1920 Thousands of dollars	Per cent increase	1921	1920	1921	1920	1921	1920
Jan.	40	14,562	13,085	11.3	56.1	55.3	26.8	27.0	38.1	45.6
Feb.........	43	15,085	13,640	10.5	55.6	54.5	22.9	26.0	44.1	47.3
Mar.........	53	18,544	17,125	8.4	56.1	57.7	23.4	19.6	40.3	44.8

Taking the returns by sections and industrial centers of the country we find, from data issued by federal bureaus, that the general textile situation in New England showed a marked improvement over February. The boot and shoe industry of that section, which accounts for over 50 per cent of the shoe production in the United States, increased operations slightly over February, but was still operating at only about 50 to 75 per cent. From a close study of the companies serving the textile centers of Massachusetts, New Hampshire, and Connecticut, it was found that the operations of these power companies checked these

TABLE II

CENTRAL-STATION RETURNS BY SECTIONS OVER A TWELVE-MONTH PERIOD

	Month	Percentage of installed ratings represented	New England States			Percentage of installed ratings represented	Atlantic States			Percentage of installed ratings represented	North Central States			Percentage of installed ratings represented	South Central States			Percentage of installed ratings represented	Pacific and Mountain States		
			1920 Thousands	1919 Thousands	Per cent increase		1920 Thousands	1919 Thousands	Per cent increase		1920 Thousands	1919 Thousands	Per cent increase		1920 Thousands	1919 Thousands	Per cent increase		1920 Thousands	1919 Thousands	Per cent increase
Kw.-hr. Output	April....	82	187,174	144,922	29.1	65	883,264	701,778	25.9	74	857,467	687,751	24.7	56	135,140	99,877	35.2	79	540,647	464,231	16.7
	May....	82	188,566	148,186	27.5	65	854,631	711,276	20.0	74	862,127	700,095	23.5	56	137,779	98,815	39.2	79	588,457	521,544	12.6
	June....	82	189,934	149,607	26.5	66	865,714	721,688	19.9	74	855,013	681,780	25.5	56	132,733	99,660	33.2	79	587,437	522,901	12.2
	July	82	190,668	159,000	20.0	66	881,241	714,485	23.5	74	841,351	702,302	19.7	56	138,937	106,460	30.1	79	614,934	551,959	13.4
	Aug.....	82	194,028	171,002	13.5	66	905,170	728,097	24.2	74	891,712	750,787	18.6	56	147,082	111,573	32.0	79	631,183	541,640	16.5
	Sept.....	82	194,730	170,593	14.1	66	905,872	758,737	19.5	74	878,237	758,017	15.9	56	147,524	113,649	30.0	79	607,816	526,464	15.5
	Oct.	82	196,310	191,132	2.7	66	964,739	841,694	14.5	74	896,241	817,757	9.5	56	157,267	126,769	24.1	79	583,068	522,136	11.7
	Nov.....	82	193,231	183,624	5.4	66	953,436	825,011	15.5	74	895,229	861,352	10.5	56	144,889	125,438	15.0	79	554,920	507,977	9.2
	Dec.....	82	210,494	227,403	—7.4	66	969,909	917,945	5.7	74	903,628	852,264	5.9	56	140,485	133,419	5.3	79	568,038	517,715	9.6
			1921	1920			1921	1920			1921	1920			1921	1920			1921	1920	
	Jan.	81	200,269	247,800	—19.2	77	1,003,223	1,043,650	—3.9	73	860,643	956,078	—10.0	62	144,936	145,336	—0.3	81	556,561	550,685	1.1
	Feb.	81	178,694	216,890	—17.6	77	901,942	969,318	—7.0	73	790,935	883,545	—10.5	63	131,654	132,537	—0.7	81	453,928	508,961	—10.8
	Mar.....	81	204,952	230,125	—10.9	79	1,028,624	1,117,441	—8.0	73	895,900	943,470	—5.0	63	139,650	136,971	1.9	81	543,367	751,936	—27.2
			1920	1919			1920	1919			1920	1919			1920	1919			1920	1919	
Revenue	April....	82	$5,087	$3,943	29.0	64	$17,700	$14,383	23.5	57	$12,690	$10,042	26.9	54	$2,952	$2,181	35.2	79	$7,118	$5,992	19.2
	May	82	4,897	3,741	30.1	64	16,624	13,631	21.9	57	12,471	9,853	26.8	54	2,829	2,140	32.0	79	7,067	6,147	15.1
	June....	82	4,948	3,778	30.5	65	16,525	13,449	22.1	57	12,412	9,776	26.9	54	2,849	2,127	33.9	79	7,700	6,398	20.5
	July	·82	5,009	3,802	28.5	65	16,899	13,438	25.5	57	12,822	9,793	30.9	54	2,747	2,194	35.0	79	9,131	6,948	31.5
	Aug.....	82	5,075	4,093	24.0	65	17,210	13,731	25.9	57	13,497	10,151	32.9	54	3,168	2,281	38.1	79	8,460	6,457	31.1
	Sept.....	82	5,409	4,296	25.9	65	18,081	14,456	24.5	57	13,834	10,522	31.5	54	3,262	2,386	36.5	79	8,638	6,549	32.0
	Oct......	82	5,675	4,623	22.7	65	19,201	15,722	22.0	57	14,458	11,667	23.9	54	3,504	2,551	37.3	79	8,532	6,492	31.5
	Nov.....	82	5,898	5,017	17.5	65	20,938	17,119	22.2	57	15,158	12,561	20.8	54	3,853	2,910	32.4	79	8,775	7,104	23.5
	Dec.	82	6,548	5,744	14.0	65	22,332	19,149	16.7	57	16,004	13,142	21.8	54	3,722	3,113	19.8	79	9,091	7,432	22.3
			1921	1920			1921	1920			1921	1920			1921	1920			1921	1920	
	Jan.....	81	6,379	6,170	3.5	74	22,180	19,225	15.3	59	16,818	14,436	17.3	62	4,155	3,484	19.3	81	9,323	7,546	23.6
	Feb.	81	5,925	5,728	3.4	74	21,489	18,317	17.4	59	15,981	14,071	13.7	62	3,915	3,329	17.6	81	8,468	7,179	18.0
	Mar.....	81	5,788	5,566	3.8	76	21,761	18,870	15.4	59	15,945	14,108	12.5	63	3,869	3,246	19.2	81	8,489	7,224	17.5
Operating Expenses:			1921	1920			1921	1920			1921	1920			1921	1920			1921	1920	
	Jan.....	34	$1,098	$1,288	—14.7	48	$6,373	$5,411	17.8	28	$3,941	$3,451	14.2	37	$1,015	$905	12.2	54	$2,135	$2,030	5.2
	Feb.	35	1,069	1,242	—13.9	53	6,799	5,937	14.5	29	3,958	3,445	14.8	44	1,217	1,056	15.5	55	2,042	1,963	3.9
	Mar.....	46	1,560	1,642	—5.0	59	7,874	7,274	8.2	35	4,597	4,191	9.8	53	1,704	1,453	17.3	79	2,809	2,565	9.4

government data almost exactly. The companies serving large shoe factories reported an average daily output practically equal to that of February, which fact indicated a slight resumption of activity in the shoe factories, since otherwise the advancing season would have reduced the energy demand by reason of reduced lighting requirements. These and other increases in the industrial load of this section resulted in an increased daily energy output over February of 280,000 kilowatt-hours, and reflected almost perfectly the degree of increased industrial activity.

During March the Atlantic States presented two conflicting tendencies. In the Middle Atlantic States, which group includes the great industrial states of New York, New Jersey, and Pennsylvania, there was a material increase of activity among the industries closely allied with the automobile industries; but on the other hand, the iron and steel industry and other metal products experienced a decidedly greater slump during that month, and the coal-mining districts, such as those of West Virginia, were operating at only about 25 per cent capacity. The reports of light and power companies serving the automobile centers of New York State were materially in excess of those made during previous months in spite of the rapidly advancing season. On the other hand, companies serving the large iron and steel districts, and especially the coal mining districts, showed almost unprecendented drops in electrical output.

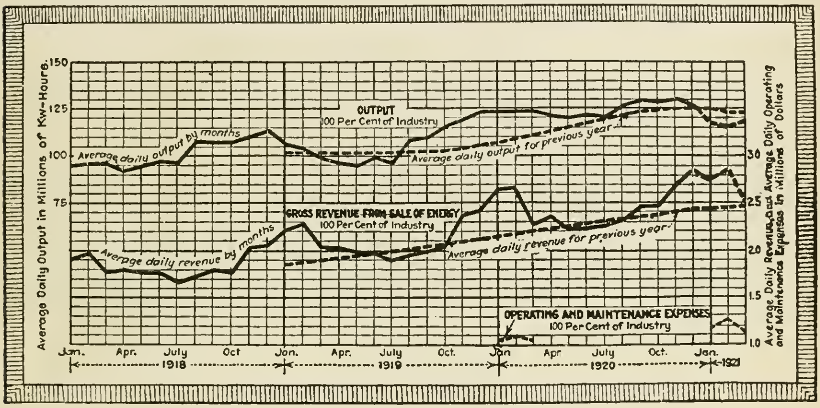
In the South Atlantic States conditions were reported as fast approaching normal in the textile and lumber industries which consume over 46 per cent of the electrical energy generated in the Southern States. Reports from light and power companies operating in the Southern States showed a small increase in the aggregate, which would undoubtedly have been much larger had the decreased lighting load not tended to pull down the gains from an increased industrial power load.

Taking the Atlantic Section as a whole, therefore, we find that the increased power requirements of the South and of a few industries of the Middle Atlantic States were sufficient to overcome the curtailments of the steel and coal-mining industries, resulting in an increased daily output in the Atlantic States of 3,600,000 kilowatt-hours over that reported for February.

Similar conflicting tendencies were also experienced in the North Central States. The greatly decreased power requirements of the iron and steel industry were more than offset by the greatly increased energy requirements of the automobile and related industries, operations in which increased more than 63 per cent over those of February.

But after accounting for the decreased lighting requirements, the resulting energy output of this section was only a trifle more than that reported for February, indicating a slight increase in industrial activity in the aggregate.

Activity in all the copper, lead, and coal mining centers of the Mountain States was considerably curtailed during March, and general industrial activity in this section was at a low ebb. Reports from light and power companies in the Mountain States indicated these very conditions in their subnormal electrical output. Generally speaking, conditions throughout the Pacific States were slightly improved, and the increased electrical output of these three states was sufficient to make the aggregate average daily output of the Mountain-Pacific States about 8 per cent greater than that reported in February.



Central Station operations through March, 1921

Knowing the location of the various classes of industrial activity, and having at hand a report of the operations of the light and power companies serving these centers, it is entirely possible to plot the degree of industrial activity in any section or industrial center, and for any special industry in that center. Were it possible to obtain detailed reports of the distribution of the central station generating load among the various industries, a study of the monthly operations of the electric light and power industry would give the most accurate story obtainable of industrial activity.

Most government and private reports on industrial conditions are based on returns from a small percentage of the manufacturing plants, and generally it is only the larger plants that make the necessary reports. The electric light and power industry, however, goes into all kinds of industrial life, both large and small. The interpretations which are to be drawn from the operations of the energy-producing plants tell the story not only of the larger industrial plants but of the small factories also. In a word, the real condition of affairs in the industrial world is accurately pictured by the operations of the electrical industry. And this must be more and more the case each year. The central generating stations cannot install generators and distributing systems fast enough to keep up with the demands of the industrial world for electrical energy.

Each new industrial customer means just one more step toward 100 per cent reflection of activity in all factories. Many plants possibly will never be electrified; but the large proportion which will be electrified will be sufficient to render the monthly reports of electric light and power companies true weathervanes of the storms approaching in the industrial skies and of the lifting of the clouds of depression which may have settled over industry as a whole.

We have a new prophet in our midst. Let us not fail to recognize him and his power and to give to the electric light and power industry the place that it deserves, not only as a great deliverer of mankind from drudgery and darkness, but also as a true prophet of that which is and that which is to come.

THE MATHEMATICAL REPRESENTATION OF FREQUENCY DISTRIBUTIONS

BY HARRY C. CARVER, *University of Michigan*

SECTION I. DISTRIBUTIONS OF GRADUATED VARIATES*
SECTION II. DISTRIBUTIONS OF INTEGRAL VARIATES*
SECTION III. DIFFERENCE EQUATION GRADUATION
SECTION IV. APPLICATION OF THE HYPERGEOMETRIC SERIES

$$\text{(A)} \quad u_x = {}_{pn}C_{r-x} \quad {}_{qn}C_x$$

$$\text{(B)} \quad u_x = {}_{pn}H_{r-x} \quad {}_{qn}H_x$$

SECTION III

DIFFERENCE EQUATION GRADUATION

Certain geometrical properties of unimodal frequency distributions suggest that any associated frequency function may be represented as a solution of the difference equation.

$$\text{(1)} \qquad \frac{\Delta y_x}{\Delta_x} = \frac{y_x(a-x)}{f(x)}$$

since

(a) if there be one mode only there must be a value of $x = a$ for which $\Delta y_x = 0$, and

(b) towards the extremes, the finite difference between two successive ordinates must approach zero as y_x diminishes in value.

The balance of the difference equation of the unknown theoretical law of distribution may be represented by a function, $f(x)$, appearing in the denominator.

We shall now *assume* that $f(x)$ may be expanded in a power series which in practice is found to be rapidly convergent. The merits of this important assumption will be discussed briefly later.

Expressing (1) then as

$$(b_0 + b_1 x + b_2 x^2 + \ . \ . \ . \ )\Delta y_x = (a-x) y_x \cdot \Delta x,$$

multiplying through by x^n and summing with respect to x yields

$$\text{(2)} \ b_0 \Sigma x^n \Delta y_x + b_1 \Sigma x^{n+1} \Delta y_x + b_2 \Sigma x^{n+2} \Delta y_x + \ . \ . \ . \ = (a \Sigma x^n y_x - \Sigma x^{n+1} y_x) \Delta x.$$

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* Sections I and II of this paper appeared in the June issue of the QUARTERLY PUBLICATIONS.

If the range of the distribution be from $x = -\infty$ to $x = \infty$, we have by finite integration by parts

$$\sum_{x=-\infty}^{\infty} x^n \Delta y_x = x^n y_x - \Sigma\left\{(x+\Delta x)^n - x^n\right\} y_{x+\Delta x}\Big]_{x=-\infty}^{\infty}$$

$$= -\Sigma\left\{x^n - (x-\Delta x)^n\right\} y_x\Big]_{x=-\infty}^{\infty}$$

$$(3) \qquad = -nC_1 \Sigma x^{n-1} y_x \Delta x + {}_nC_2 \Sigma x^{n-2} y_x (\Delta x)^2 - \; . \; . \; .$$

When dealing with distributions of graduated variates, Δx should be permitted to approach zero as a limit.

Thus, equations (1), (2), and (3) become

$$(1a) \quad \frac{1}{y}\frac{dy}{dx} = \frac{a-x}{b_0 + b_1 x + b_2 x^2 + \; . \; . \; .}$$

$$(2a) \quad b_0 \int x^n dy + b_1 \int x^{n+1} dy + b_2 \int x^{n+2} dy + \; . \; . \; . = a \int x^n y dx - \int x^{n+1} y dx$$

$$(3a) \quad \int x^n dy = -N \cdot n\nu'_{n-1}.$$

If we choose the mean of the distribution as origin and give n in (2a) successively the values 0, 1, 2, . . . we obtain

$$(4a) \left\{ \begin{array}{lllll} a & & +b_1 & + \; . \; . \; . & = 0 \\ & b_0 & & +3\nu_2 b_2 + \; . \; . \; . & = \nu_2 \\ \nu_2 a & & +3\nu_2 b_1 & +4\nu_3 b_2 + \; . \; . \; . & = \nu_3 \\ \nu_3 a & +3\nu_2 b_0 & +4\nu_3 b_1 & +5\nu_4 b_2 + \; . \; . \; . & = \nu_4 \end{array} \right.$$

etc.

For distributions of graduated variates we take the common difference between any two successive class magnitudes as the unit for x, (thus $\Delta x = 1$) and giving n successively the values 0, 1, 2, . . . as before we obtain from (2) and (3)

$$(4) \left\{ \begin{array}{lllll} a & & +b_1 & -b_2 + \ldots & = 0 \\ & b_0 & -b_1 + & (3\nu_2+1)b_2 + \ldots & = \nu_2 \\ \nu_2 a & -b_0 + & (3\nu_2+1)b_1 + & (4\nu_3 - 6\nu_2 - 1)b_2 + \ldots & = \nu_3 \\ \nu_3 a + & (3\nu_2+1)b_0 + & (4\nu_3 - 6\nu_2 - 1)b_1 + & (5\nu_4 - 10\nu_3 + 10\nu_2 + 1b_2 + \ldots & = \nu_4 \end{array} \right.$$

etc.

It should be noted that the moments of (4a) are defined by

$$\nu_n = \int x^n y dx$$

whereas those of (4) are given by

$$\nu_n = \Sigma x^n y_x.$$

A simultaneous solution of equations ($4a$) determines the constants of the *differential* equation ($1a$), which on integration produce Pearson's system of Generalized Probability Curves.

Equations (4) likewise determine the constants for the corresponding *difference* equation (1), when $\Delta x = 1$.

If for a particular distribution the series $b_0 + b_1x + b_2x^2 + \ldots$ converges rapidly and it is possible to neglect all terms containing powers of x greater than the second, solutions of ($4a$) and (4) yield, letting

$$\beta_1 = \frac{\nu_3^2}{\nu_2^3} \text{ and } \beta_2 = \frac{\nu_4}{\nu_2^2}.$$

TABLE I

Differential values	Const.	Difference values
$\dfrac{-\frac{\nu_3}{\nu_2}(\beta_2+3)}{2(5\beta_2-6\beta_1-9)}$	a	$\dfrac{-\frac{\nu_3}{\nu_2}\left(\beta_2+3-\frac{1}{\nu_2}\right)}{2\left(5\beta_2-6\beta_1-9+\frac{1}{\nu_2}\right)}-\dfrac{1}{2}$
$\dfrac{\nu_2(4\beta_2-3\beta_1)}{2(5\beta_2-6\beta_1-9)}$	b_0	$\dfrac{\nu_2\left(4\beta_2-3\beta_1-\frac{1}{\nu_2}\right)}{2\left(5\beta_2-6\beta_1-9+\frac{1}{\nu_2}\right)}-a$
$-a$	b_1	b_2-a
$\dfrac{2\beta_2-3\beta_1-6}{2(5\beta_2-6\beta_1-9)}$	b_2	$\dfrac{2\beta_2-3\beta_1-6+\frac{1}{\nu_2}}{2\left(5\beta_2-6\beta_1-9+\frac{1}{\nu_2}\right)}$

If the series, $f(x)$, converges so rapidly that the term b_2x^2 may also be neglected, that is in cases where the value of b_2 is not appreciably greater than its probable error, we have

TABLE II

Differential values	Const.	Difference values
$-\dfrac{\nu_3}{2\nu_2}$	a	$\dfrac{-\nu_3}{2\nu_2}-\dfrac{1}{2}$
ν_2	b_0	ν_2-a
$-a$	b_1	$-a$

In application, the difference equation has certain advantages over the differential equation. Thus, a knowledge of the values of the constants of the differential equation permits us to compute the theoretical ordinates only after the integration of the differential equation, the constant of integration being determined by imposing the condition that the sums of the graduated and ungraduated frequencies must be equal.

The difference equation, however, requires no integration, since a knowledge of the constants permits us to compute first all necessary values of $\frac{\Delta y_x}{y_x}$ and then $\frac{y_{x+1}}{y_x}$ from which ordinates proportional to those required may be computed by successive multiplication. The condition that the sum of the graduated frequencies must equal that of the ungraduated determines the proper proportional factor.

For numerical illustrations of the use of the difference equation method for graduating complete distributions as well as "stumps" of distributions, reference may be made to "On the Graduation of Frequency Distributions" by the writer.*

SECTION IV

APPLICATION OF THE HYPERGEOMETRIC SERIES

$$\text{(A)} \quad u_x = {}_{pn}C_{r-x} \quad {}_{qn}C_x$$
$$\text{(B)} \quad u_x = {}_{pn}H_{r-x} \quad {}_{qn}H_x$$

Critical investigations of the variations which are found to exist in apparently homogeneous statistical data have led to the development of various theories of frequency distribution.

One of the first of these, known to biologists as Quetelet's Law, states that the distribution of individuals ranked according to some common character in a frequency series may be represented by the successive terms of the expansion of the point binomial

$$N(p+q)^r,$$

that is to say

$$(1) \qquad N\{p^r + {}_rC_1 p^{r-1}q + {}_rC_2 p^{r-2}q^2 + \ . \ . \ . \ + q^r\}$$

where $p+q=1$

$N =$ the total frequency of the distribution.

$r =$ an integer, representing, therefore, one less than the number of classes in the theoretical distribution.

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* Published in the *Proceedings of the Casualty Actuarial and Statistical Society of America*, vol. vi, part 1, No. 13.

A student of probabilities, however, is more apt to associate the name of Bernoulli with this series, since the successive terms are merely the frequency expectations of r, $r-1$, $r-2$, . . . 0 occurances in N trials of r independent events each, where the probability of the happening of each event is designated by p and of its non-happening by q.

The difference equation of Quetelet's Law, taking the position of the first term as origin, is

$$\frac{y_{x+1}}{y_x}=\frac{N\cdot {}_rC_{x+1}p^{r-x-1}q^{x+1}}{N\cdot {}_rC_xp^{r-x}q^x}=\frac{(r-x)q}{(x+1)p}$$

or

$$\frac{\Delta y_x}{y_x}=\frac{rq-p-x}{(x+1)p}.$$

If the origin be now shifted to the mean, rq units distant, the new difference equation becomes

$$\frac{\Delta y_x}{y_x}=\frac{-p-x}{p(1+rq)+px} \tag{2}$$

which is of the form

$$\frac{\Delta y_x}{y_x}=\frac{a-x}{b_0+b_1x}.$$

From the values of the constants of the difference equations given in Table II we have

$$p=\frac{\nu_2+\nu_3}{2\nu_2},\quad q=\frac{\nu_2-\nu_3}{2\nu_2},\quad r=\frac{4\nu_2{}^3}{\nu_2{}^2-\nu_3{}^2}. \tag{3}$$

From the above we see that if p, q, and r are to have any real significance, the absolute value of ν_3 must be less than ν_2. Otherwise r would be negative and either p or q would be greater than unity.

An important limit of Quetelet's Law is obtained by permitting q to approach zero and r infinity in such a manner that the product rq, representing the distance from the origin of the series to the mean, remains a constant and equal to m.

This limit,

$$\frac{N}{e^m}\left[1+m+\frac{m^2}{\underline{|2}}+\ .\ .\ .\ +\frac{m^x}{\underline{|x}}+\ .\ .\ .\ \right] \tag{4}$$

is known as Poisson's Exponential Binomial Limit, and is often referred to as the Law of Small Numbers.

The criterion for this series is obviously $\nu_2=\nu_3$.

In the *Philosophical Transactions of the Royal Society of London* (vol. 186, part 1, p. 360), Pearson presents a generalized series which is more general and powerful than the point binomial mentioned above.

It may be developed as follows:

If from a bag containing pn black and qn white balls, r balls are withdrawn without replacements, the chances that the r balls withdrawn will contain r, $r-1$, $r-2$, . . . 2, 1, 0 black balls are given by the successive terms of the hypergeometric series

$$(5) \qquad \frac{1}{{}_nC_r}\left\{ {}_{pn}C_r + {}_{pn}C_{r-1\,qn}C_1 + {}_{pn}C_{r-2\,qn}C_2 + \ .\ .\ .\ + {}_{qn}C_r \right\}.$$

The difference equation of this series, referred to the mean which is rq units distant from the first term, is

$$(6) \qquad \frac{\Delta y_x}{y_x} = \frac{(r\,\overline{2p-1} - pn - 1) - (n+2)x}{(r\,\overline{1-p} + 1 + x)(p\,\overline{n-r} + 1 + x)}.$$

Comparing equation (6) with (4) of Section III, we obtain the following for the hypergeometric series $u_x = {}_{pn}C_{r-x\,qn}C_x$:

$$(7) \quad \left\{ \begin{array}{l} \nu_2 = rpq\dfrac{n-r}{n-1} \\[2ex] \nu_3 = \nu_2(p-q)\dfrac{n-2r}{n-2} \\[2ex] \nu_4 = \dfrac{\nu_2}{(n-2)(n-3)}\left\{ 3(n-1)\left(n+6-\dfrac{2}{pq}\right)\nu_2 + n(n+1) - 6pqn^2 \right\}. \end{array} \right.$$

But here again we find that for distributions of integral variates our results are unintelligible unless ν_3 is in absolute value less than ν_2.

Again, since for this series $b_2 = \dfrac{1}{n+2}$ we have from Table I,

$$(8) \qquad n = \frac{6(\beta_2 - \beta_1 - 1)}{2\beta_2 - 3\beta_1 - 6 + \dfrac{1}{\nu_2}};$$

and a few trials will convince one that for many of the distributions that are met in practice this solution yields a negative value for n, and that this occurs when $\nu_3 > \nu_2$.

If we now consider the hypergeometric series

$$u_x = {}_{pn}H_{r-x} \cdot {}_{qn}H_x$$

where ${}_nH_r$ denotes the number of combinations of n things taken r at a time when repetitions are allowed, *i. e.*, ${}_nH_r = {}_{n+r-1}C_r$, we have

$$\text{(9)} \qquad \frac{\Delta y_x}{y_x} = \frac{(r\,\overline{1-2p}+1-pn)-(n-2)x}{(r\,\overline{1-p}+1+x)(p\,\overline{n+r}-1-x)},$$

where the mean, which is also at rq, is taken as the origin.

Comparing equation (9) with (4) of Section III we obtain for the series $u_x = {}_{pn}H_{r-x} \cdot {}_{qn}H_x$

$$\text{(10)} \quad \begin{cases} \nu_2 = rpq\dfrac{n+r}{n+1} \\ \nu_3 = \nu_2(p-q)\dfrac{n+2r}{n+2} \\ \nu_4 = \dfrac{\nu_2}{(n+2)(n+3)}\left\{3(n+1)\left(n-6+\dfrac{2}{pq}\right)\nu_2 + n(n-1) - 6pqn^2\right\}. \end{cases}$$

It may now be noted that equations (9) and (10) may be obtained directly from (6) and (7) by replacing n in the latter by $(-n)$.

If for convenience we designate the point binomial or Bernoulli's series by Series B, the hypergeometric series $u_x = {}_{pn}C_{r-x}\,{}_{qn}C_x$ as Series C, and $u_x = {}_{pn}H_{r-x}\,{}_{qn}H_x$ as Series H, we see that Series H may be used for those distributions for which Series B and C are meaningless.

An analysis of the means and dispersions of these three series is enlightening. From the following table we note that although their means are identical the dispersion of Series C is always less and that of Series H greater than the Bernoullian dispersion. Moreover, as n approaches infinity, the dispersions of Series C and H approach the Bernoullian as a limit from opposite sides.

TABLE III

Series	Mean	Dispersion
C	rq	$rpq\frac{n-r}{n-1}$
B	rq	rpq
H	rq	$rpq\frac{n+r}{n+1}$

Inasmuch as the Bernoulli Series, because of its rather extensive degree of freedom, is itself a powerful "closed" graduation function, it follows that the combination of these three series—affording an additional continuous degree of freedom—is capable of graduating practically any unimodal distribution.

These considerations throw an interesting light on the convergence of $f(x)=b_0+b_1x+b_2x^2+\ \ldots$ in the denominator of either the difference or differential equation. If we stop with b_1x the freedom is restricted to that of a point binomial, and the addition of b_2x^2 increases the freedom to at least that of the hypergeometric series.

At the present time tables, based on formulae (7) and (10), are being prepared which will enable one to obtain by inspection the proper values of p, q, r, and n when the values of the moments are known. By this method it is hoped that a simple method of graduating frequency distributions may be available, and, what is more important, that something may be accomplished in the direction of classifying distributions.

NOTES

AN EXAMINATION OF THE WAGE STUDIES OF THE NATIONAL INDUSTRIAL CONFERENCE BOARD

By Paul H. Douglas, *University of Chicago*

Wartime Changes in Wages. September 1914–March 1919. National Industrial Conference Board, Research Report No. 20, 128 pp.

Changes in Wages During and Since the War. September 1914–March 1920. National Industrial Conference Board, Research Report No. 31, 53 pp.

I

In these two studies the National Industrial Conference Board has attempted to survey the movement of money wages since September, 1914, in a number of industries. The first report covered the following manufacturing industries: metal, cotton, woolen, silk, boots and shoes, paper, rubber, and chemicals; the second added furniture, hosiery and knit goods, printing and publishing, and leather tanning.

The earlier study concerned itself with only two methods of computing wages: (1) actual weekly earnings, *i. e.*, the amounts actually received in the pay envelopes; (2) the hourly earnings, *i. e.*, the actual weekly earnings divided by the number of hours actually worked. Hourly earnings should be clearly distinguished from hourly wage rates in that they include their portion of any bonuses that may have been paid the worker. To illustrate: An employee with an hourly rate of fifty cents works sixty hours a week and receives not only sixty hours' pay but a bonus of ten hours' pay in addition for overtime. His weekly earnings are therefore $35.00 and his average hourly earnings one-sixtieth of this, or 58.3 cents, whereas his wage rate is only 50 cents an hour. The Board states that the investigations of the National Metal Trades Association showed that "averages of hourly earnings . . . generally exceeded the corresponding averages of hourly rates by from two to five cents."* The later investigation introduced a further method, namely, that of full-time weekly earnings, *i. e.*, the hourly earnings multiplied by the number of hours considered as the standard week's work. Thus, a plant operating under the forty-eight hour week would multiply the average hourly earnings by that figure. It is clear that this third basis is not one of actual earnings, since it makes no allowance for unemployment, underemployment, or overtime. It would naturally exceed the actual weekly earnings in those cases in which the number of hours worked was less than the standard, and would fall below them when overtime was worked. It was indeed this third basis upon which the Board leaned the most heavily in the second report, although data on this point were missing for the paper and chemical industries.

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* Research Report No. 31, p. 1.

The second report broadened the scope of investigation in still another way; it included additional plants and consequently more employees. Thus, the second investigation covers for September, 1918, approximately 13,000 more employees in the metal industry than did the first, 4,000 more in the cotton industry, 20,000 more in woolens, and certain increases in other occupations as well.

One difficulty with the studies is their lack of a general summary. The first eschewed even finding a percentage increase for any industry as a whole, and contented itself with merely showing the increase by sexes and by occupations within each industry. The second emphasizes the comparison by sexes, but shows the increase for each of the crafts studied for the single date of March, 1920, as compared with September, 1914, and then only for hourly earnings and full-time weekly earnings—not for actual weekly earnings. Following the partial example of the report, the reviewer has employed a similar method and has weighted the indices given for the sexes in each industry by the number of each sex.* By this method he has secured the following indices for all three bases of wage computation both for March, 1920, and for September, 1918. From these indices, index numbers for the combined twelve industries have been computed. One is the simple arithmetic average of the indices for the separate industries, while the other is obtained by weighting the indices for each industry by the number of employees included in the wage study for that industry. It is not at all certain that the second method is under the circumstances more accurate than the first, since the relative numbers examined by the Board in the various industries does not necessarily correspond to the relative actual number employed in the country as a whole. Thus, the study made by the Board of the rubber industry in March, 1920, applied to 63,000 workers, while that for printing and publishing covered only 1,400. The weighted index, therefore, gives rubber forty-five times the importance attached to printing and publishing. Both the weighted and unweighted index numbers, however, are given for use.

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* The data for the chemical and furniture industries applied only to men. Hence weighting was not necessary here.

TABLE I

RELATIVE WAGES—ALL WORKERS

(September 1914 = 100)

Industry	Hourly earnings		Actual weekly earnings		Full-time weekly earnings	
	September, 1918	March, 1920	September, 1918	March, 1920	September, 1918	March, 1920
Metal manufacturing....	179	210	196	213	170	191
Cotton manufacturing...	205	272	206	251	206	236
Woolen manufacturing ..	204	272	203	252	203	240
Silk manufacturing	188	282	191	259	189	263
Boots and shoes........	160	205	157	187	145	182
Paper manufacturing....	179	213	179	220	...	...
Rubber manufacturing ..	197	267	179	238	197	243
Chemical manufacturing.	175	261	193	273	...	...
Furniture manufacturing	158	217	161	212	158	194
Hosiery and knit goods..	191	274	229	259	203	250
Leather tanning........	195	270	212	274	191	236
Printing and publishing .	138	196	130	186	129	185
Unweighted average..	181	245	186	235	179	222
Weighted average....	186	250	193	234	182	226

In order to translate these indicated increases of money wages into relative real wages, it is of course necessary to compare them with the increase in the cost of living during these periods. The three sources from which we can derive cost of living figures for approximately this period are: (1) the studies of the National Industrial Conference Board itself; (2) an average of the cost of living indices obtained by the United States Bureau of Labor Statistics for eighteen cities; and (3) the cost of living index for Massachusetts computed by the Special Commission on the Necessaries of Life of that state. This comparison is shown in the following table:

INCREASE IN THE COST OF LIVING* 1914–MARCH, 1920

	Bureau of Labor Statistics Eighteen cities December, 1914 = 100	National Industrial Conference Board July, 1914 = 100	Massachusetts Commission September, 1914 = 100
September, 1918.......	164.6	158.6	158.0
March, 1920...........	205.0	194.8	187.4

* The average increase in the cost of living for the eighteen cities is given for December, 1917, December, 1918, December, 1919, and June, 1920. The figures for September, 1918, and March, 1920, were secured on the assumption that the increase was evenly distributed through the months between the dates for which the figures were at hand. The same method was used with the statistics of the National Industrial Conference Board to secure the figure for September, 1918.

It will be seen that the figures of the Massachusetts Commission and the National Industrial Conference Board are from six to eighteen points below those of the Bureau of Labor Statistics. In all probability, however, the data of the Bureau of Labor Statistics are more reliable for the larger cities than are those of the other two. The situation in Massachusetts was undoubtedly not typical of the country as a whole, for that state had an oversupply of houses at the outbreak of the war and rents in consequence rose much more slowly there than in other parts of the country. And it is doubtful whether the investigations of the National Industrial Conference Board were made as carefully or as accurately as those of the Bureau.

We may now compare the various indices of money wages as computed by the National Industrial Conference Board with the indices of the cost of living, and secure the consequent indices of real wages.

TABLE II

PURCHASING POWER OF WAGES BASED ON WAGE STATISTICS OF NATIONAL INDUSTRIAL CONFERENCE BOARD

(September, 1914 = 100)

Basis of wage computation	September, 1918			March, 1920		
	Bureau of Labor Statistics index	Massachusetts Commission index	National Industrial Conference Board index	Bureau of Labor Statistics index	Massachusetts Commission index	National Industrial Conference Board index
HOURLY EARNINGS						
Simple average	110	114	114	120	126	131
Weighted average	113	117	117	122	128	133
ACTUAL WEEKLY EARNINGS						
Simple average	113	117	117	115	121	125
Weighted average	118	122	122	114	120	125
FULL-TIME WEEKLY EARNINGS						
Simple average	109	113	113	108	114	118
Weighted average	111	115	115	110	116	120

This apparently shows an increase in real wages of approximately 10 per cent during the war, by whatever method of computation is used. This result is so greatly at variance with other studies of wages in war time,* which showed on the whole a decline in real wages, that it should be given the closest scrutiny before being accepted.

II

Fortunately, the investigations of the National Industrial Conference Board can be checked up with those of the United States Bureau of

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* See the article by Frances Lamberson and myself, "The Movement of Real Wages, 1890–1918," in the *American Economic Review*, September, 1921.

Labor Statistics from 1914 to 1918 with regard to hourly earnings and full-time weekly earnings in three of the industries; namely, boots and shoes, woolen and worsted manufacturing, and cotton manufacturing. Bulletins 260, 261, and 262 respectively of the Bureau of Labor Statistics contain the data for the industries. These data were derived from actual payrolls, as was also that of the National Industrial Conference Board, and the definition given by each to "hourly earnings" and "full-time weekly earnings" is the same. The bulletins of the Bureau of Labor Statistics do not give a wage index for each industry as a whole, but they do give indices for practically all of the various occupations within the industry. The reviewer has, therefore, (1) taken the wage index for each *occupation* wherever given, and has shifted the base upon which the 1918 wage is computed to 1914; (2) computed an index for 1918 on a 1914 base from the actual money wages shown in the bulletins for those occupations for which an index was not given; (3) weighted the index for each occupation by the number employed.* By this method the relative increase in wages has been secured for each industry from 1914 to 1918 for hourly earnings and for full-time weekly earnings, the results of which are shown in Table III in comparison with those of the National Industrial Conference Board.

TABLE III

COMPARISON OF WAGE INCREASES IN 1918 OVER 1914 AS SHOWN BY THE INVESTIGATIONS OF THE NATIONAL INDUSTRIAL CONFERENCE BOARD AND THE UNITED STATES BUREAU OF LABOR STATISTICS

Industry	Hourly earnings			Full-time weekly earnings		
	Increase as per National Industrial Conference Board	Increase as per United States Bureau of Labor Statistics	Relation of National Industrial Conference Board to Bureau of Labor Statistics	Increase as per National Industrial Conference Board	Increase as per United States Bureau of Labor Statistics	Relation of National Industrial Conference Board to Bureau of Labor Statistics
Boots and shoes	60	39.6	+20.4	45	33.3	+11.7
Woolen and worsted manufacturing	104	86.7	+17.3	103	85.1	+17.9
Cotton manufacturing	105	75.5	+29.5	106	72.6	+33.4

A comparison of the statistics for these three industries, therefore, shows that the National Industrial Conference Board's figures for increases in hourly earnings are from 17.3 per cent to 29.5 per cent in excess of those of the Bureau of Labor Statistics, and for full-time weekly earnings, from 11.7 per cent to 33.4 per cent higher.

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* The National Industrial Conference Board also weighted each occupation by the number employed in order to get a figure for each industry as a whole.

Before attempting to determine the possible reasons for this difference, let us analyze the nature of the disparity somewhat more closely. In doing this the writer has compared the money wages for 1914 and 1918 for the various occupations within each industry as given by the National Industrial Conference Board, with the money wages listed for that occupation by the Bureau of Labor Statistics. Considerable difficulty has been experienced in doing this because of the different nomenclature used by the two organizations; but this has been largely overcome, and a comparison of many occupations has been accomplished. The detailed analysis that was made is too cumbersome for inclusion in this review, but the results shown may be briefly summarized:

(1) In the boot and shoe industry, the hourly earnings in 1914 as listed by the National Industrial Conference Board were, with only three exceptions,* from two to six cents below those given by the Bureau of Labor Statistics, and averaged a full 12 per cent less. The full-time weekly earnings in 1914 as shown by the Board were (with one exception) from $1.35 to $4.70 less than those given by the Bureau, and ranged from 10 to 25 per cent less. By 1918, however, the hourly earnings, according to the Conference Board, were (with two exceptions) from one to six cents *above* those of the Bureau, and averaged approximately 6 per cent more. Full-time weekly earnings as shown by the Conference Board also in general exceeded those of the Bureau.

(2) In the cotton manufacturing industry, the 1914 hourly earnings shown by the Conference Board (with two exceptions) exceeded those shown by the Bureau by from one to three cents, and by approximately 8 per cent. By 1918, however, the excess for the occupations compared ranged from three to twelve cents, with an average of about 28 per cent. The Board's 1914 figures for full-time weekly earnings were on the whole no higher than those of the Bureau; but by 1918 they ranged (with two exceptions) from two to five dollars more, or something over 20 per cent higher.

(3) In the woolen industry, the hourly earnings in 1914 as given by the Board were in general somewhat lower than those of the Bureau; but by 1918 they were, save for sorting, spinning, and female weavers, higher. Sorting and spinning earnings, however, were still much lower than in the corresponding scale of the Bureau. The full-time weekly earnings shown by the Conference Board were slightly lower than those

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* One of these was more than the Bureau of Labor Statistics' figure, while two were less but not as much less as two cents an hour.

of the Bureau in 1914, but by 1918 they were (with two exceptions) from $2 to $13 more, with a general average of approximately 12 per cent higher.

How, then, may these discrepancies between the investigations of the National Industrial Conference Board and those of the Bureau of Labor Statistics be accounted for, and which is the more reliable?

(1) The periods covered by the two studies are slightly different; the comparisons of the Conference Board are made between the months of September, 1914, and September, 1918, while those of the Bureau are between the average for the whole year 1914 and the average for the year 1918. It is probable that owing to the depression caused by the outbreak of the Great War in August, 1914, earnings in September of that year were slightly lower than their average for the year as a whole. Furthermore, it is probably also true that in the year 1918, characterized as it was by fast-mounting money wages, the earnings for September were somewhat higher than the average of the year taken as a whole. This might partially explain the greater increase shown by the Conference Board.

(2) The samples taken by the Conference Board were considerably smaller than those taken by the Bureau. Thus, in the cotton manufacturing industry the Board drew its statistics from the payrolls of 13,900 employees, while the Bureau's study covered 91,000 employees. In the boot and shoe industry the Board based its study upon 13,500 employees, and the Bureau upon 61,000. In woolen manufacturing the Board's figures for 1918 were based upon 37,000 employees, while those of the Bureau covered 51,000.

(3) The samples of the Conference Board were less widely distributed geographically than those of the Bureau. The Board's statistics for cotton manufacturing were drawn only from the six states of Maine, Massachusetts, Connecticut, Rhode Island, New York, and New Jersey. The Bureau included not only these states but New Hampshire and (most important of all) the Southern States as well. In the boot and shoe industry the Conference Board's figures are based on returns from eight states, while those of the Bureau are based on at least twelve.* In woolen manufacturing, however, the states included in the two investigations are identical.

(4) The plants investigated by the Conference Board were undoubtedly almost overwhelmingly non-union, while those of the Bureau included union as well as non-union plants. The membership of the Conference Board is predominantly composed of employers

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* Three factories are listed merely as being located in "other states." There is a possibility therefore that fourteen states are included.

operating non-union shops, and it is from their members that practically all of their wage statistics are taken. Now it is undoubtedly true in general that wages in non-union plants in 1914 were lower than those in union plants. Moreover, it is also probable that during the war wages in the non-union plants rose more rapidly than those in the union shops because of the great competition for labor and the fact that there were no previously agreed upon wage-rates, as in union shops, to retard the upward movement of wages. It is probable, therefore, that these factors in turn will account in part for the discrepancy between the two sets of studies.

(5) The methods used to collect data by the two bodies were different. The National Industrial Conference Board sent out requests for payrolls, and the plants that complied mailed them to the Board. The Bureau of Labor Statistics, on the other hand, sent out agents who personally secured the payrolls from the establishments, and made their computations from this material. There can be no question that the latter method is scientifically superior to the former. In the first place, there is a much greater likelihood of securing more representative returns through personal contact than through a long-distance request. Concerns with a low wage scale are especially reluctant to report their rates of payment. Secondly, there is a much greater opportunity to straighten out any difficulties that may present themselves in the material, and thus to clear up any obscurities. Therefore, although the method of collecting material followed by the Conference Board in the matter of wages is not open to the criticisms that can justly be leveled at their hours and output series, it is distinctly inferior to the method employed by the Bureau of Labor.

From the foregoing factors can we not conclude, then, that the apparent rise in real wages up to 1918 as shown by the National Industrial Conference Board has not been established? The writer believes, upon the basis of a rather extended investigation which he has directed, that from 1914 to 1918 the purchasing power of hourly wage rates decreased appreciably. He is still in doubt as to whether the purchasing power of actual weekly earnings including overtime increased or decreased during that time. During 1919 and the early part of 1920, however, he is inclined to agree that wages and wage rates perhaps rose faster than the cost of living.*

III

Finally, turning from the question of relative wages, if we accept the wage statistics of the Conference Board at their face value, we can secure interesting sidelights upon the question of the adequacy of the wages paid in terms of the various accepted standards of living.

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* See the article by Miss Lamberson and myself that has previously been referred to.

TABLE IV

AVERAGE EARNINGS OF MALE EMPLOYEES IN TWELVE INDUSTRIES AS REPORTED BY THE NATIONAL INDUSTRIAL CONFERENCE BOARD

Industry	September, 1918		March, 1920	
	Average actual weekly earnings (a)	Average yearly earnings (a ×52)	Average actual weekly earnings (c)	Average yearly earnings (c×52)
Boots and shoes	$23.62	$1,228	$28.70	$1,492
Chemical manufacturing	25.24	1,312	35.72	1,857
Cotton manufacturing	20.50	1,066	24.87	1,293
Furniture manufacturing	17.39	904	22.87	1,189
Hosiery and knit goods	22.50	1,170	27.65	1,438
Leather	23.36	1,215	30.18	1,569
Metal manufacturing	27.73	1,442	29.79	1,549
Paper manufacturing	23.20	1,206	28.82	1,499
Printing and publishing	23.69	1,232	31.67	1,647
Rubber manufacturing	27.93	1,452	36.32	1,889
Silk manufacturing	21.48	1,117	28.98	1,507
Wool manufacturing	22.93	1,192	28.70	1,492

Table IV shows the average actual weekly earnings in September, 1918, and March, 1920, for males, and what the average yearly wage would have been at this rate had fifty-two weeks been worked.

When these wage statistics are compared with the amounts necessary to maintain a family of five at these times, still further proof is furnished of the inadequacy of the average adult male's wage to support family life. The most conservative and the most carefully worked out budget for the fall of 1918 is that of the Philadelphia Bureau of Municipal Research* which fixed $1,637 as the amount necessary to support a family of five on "a minimum standard of health and comfort." It should be noted that this standard is in reality much lower than the "standard of health and decency" which has been followed by the United States Bureau of Labor Statistics.† The Philadelphia budget is indeed probably only slightly above a minimum of subsistence. This Philadelphia quantity budget was revised in November, 1919, and in August, 1920, being increased to $1,803 in the former month and $1,988 in the latter.‡ If we assume that the increase was evenly distributed throughout these nine months, we would have a figure of $1,885 as the necessary amount in March, 1920. If we compare the average yearly wages for the various industries as given in Table IV (on the basis of fifty-two weeks' work) with this budget, we see very clearly the inadequacy of the average wages of males, even during the periods of greatest business activity, adequately to support a family.

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* W. C. Beyer and others, *Workingman's Standard of Living in Philadelphia.*

† See the budgets collected by the Bureau of Applied Economics: *Standards of Living.* 1920 edition.

‡ *Citizens Business,* published by Philadelphia Bureau of Municipal Research, No. 463, p. 4.

TABLE V

A COMPARISON OF AVERAGE FULL-TIME YEARLY EARNINGS WITH THE AMOUNT NECESSARY TO MAINTAIN THE PHILADELPHIA STANDARD

Industry	September, 1918		March, 1920	
	Amount needed to bring full-time yearly earnings to minimum	Per cent increase needed to bring full-time yearly earnings to minimum	Amount needed to bring full-time yearly earnings to minimum	Per cent increase needed to bring full-time yearly earnings to minimum
Boots and shoes	$409	33	$393	26
Chemical manufacturing	325	26	28	2
Cotton manufacturing	571	54	592	46
Furniture manufacturing	733	81	696	59
Hosiery and knit goods	467	40	447	31
Leather	422	35	316	20
Metal manufacturing	195	14	336	22
Paper manufacturing	431	36	386	26
Printing and publishing	405	33	238	14
Rubber manufacturing	185	13	4*	..
Silk manufacturing	520	47	378	25
Wool manufacturing	445	37	393	26

* Indicates excess.

Table V shows that in the fall of 1918, the average wage in every one of these industries was much less than the amount required to support a family. This deficiency, save for metal and rubber manufacturing, ranged from three hundred to over seven hundred dollars. An increase of from 23 to 81 per cent was needed to bring the average earnings in ten of the twelve industries up to the minimum. By 1920 the situation was somewhat improved, but even then in only one industry would the full-time yearly earnings have been sufficient for family support. In nine of the twelve industries the gap between the yearly rate of earnings and the minimum was over three hundred dollars, and in one it was nearly seven hundred dollars. In these nine industries increases ranging from 22 to 59 per cent were needed to bring the average yearly rate up to the minimum.

Now three objections may be urged against drawing the conclusion from the above that wages are inadequate: (1) That the standard of living chosen applied only to Philadelphia and cannot be used as a standard for the rest of the country. It is of course true that the cost of living does vary from locality to locality, but it is also undoubtedly true that these differences, at least in industrial centers, are not so great as are commonly supposed. Moreover, we have no information that would lead us to infer that the cost of living in Philadelphia is less than in other manufacturing centers. (2) That the earnings of the male should not necessarily cover the cost of living for the family as a whole, since it is only proper to expect the family to receive income from other sources. This is a proposition to which one may give a qualified assent subject to judgment as to the specific source of income. Thus, while the work of the wife outside the home is sometimes proper when there are no children, it should be indulged in only in the rarest circumstances when there are children. The contributions of children over sixteen or indeed over fourteen may also be proper. Income from boarders is a source upon which a general conclusion is impossible since although it may be proper in some instances, in many others it is not. In general, however, we should beware of making total family income the test of the adequacy of the wage. The attempts of the family to secure supplementary income may indeed seriously impair the family life and vitality. (3) That since many men have either no dependents or less than four we should not use the family of five as the standard by which to measure the adequacy of men's wages, but should instead use a smaller family. A great deal of research is needed to determine how well-grounded such a contention is. At the present time we lack adequate information as to the proportion of adult males in the United States who have such a standard family, as well as the proportion that have more and those that have fewer dependents. Pending such fuller research and information, it does not seem wise to discard for the present at least the currently accepted standard in favor of a smaller family, particularly in view of the fact that even the present standard does not include (a) the initial cost of family furniture and fittings; (b) the expenses connected with the birth of children; (c) an adequate protection against the risks to which the worker is subjected; and (d) a proper provision for a human depreciation fund to protect the worker against industrial old age.

Although the above points might lead one to suppose that the indicated inadequacy of the wage is an overstatement, the following factors operate in the opposite direction: (1) The standard of living chosen was a most conservative one and one which many experts would increase. (2) The estimated yearly earnings were based upon working the full fifty-two weeks during the year at the same rate as during the period studied. This makes no allowance for unemployment save for such broken time as occurred during the period under consideration. When we remember that the amount of unemployment over a period of years is probably at least 10 per cent, this consideration assumes great importance. (3) The periods chosen were characterized by a great deal of overtime which would be non-existent at other points in the business cycle when many even of those regularly employed would work only part-time. (4) Finally, it should be remembered that the above figures were only averages. There was, therefore, a very large body of workers who received less than the amounts indicated.

Although it is manifestly impossible to balance these unknown quantities with any degree of even approximate accuracy, it does seem most probable from the figures of the National Industrial Conference Board itself that during the most outwardly prosperous period in our recent economic history a very large section of our working population did not receive a wage high enough to maintain a "decent" standard of living.

A CRITIQUE OF COST-OF-LIVING STUDIES

By George E. Barnett, *Johns Hopkins University*

The rapid changes in retail prices in recent years have since 1917 made the cost of living the dominant consideration in wage adjustments. The importance of statistical measures of these changes has correspondingly increased. In this country the first continuous index numbers of the total cost of living were inaugurated by the Bureau of Labor Statistics in 1917. They showed changes in the total cost of living separately for each of a group of fourteen cities in which shipbuilding was being carried on. At a later date similar index numbers were made for a number of other large cities. The material used in making the separate city indices was still later combined into an index number for the country as a whole.

Reports of its studies of the cost of living were first published by the Industrial Conference Board in August, 1918.* The Board does not calculate index numbers for separate cities, but only an index number of the cost of living in the United States as a whole. Since the index numbers for the United States issued by the Bureau of Labor Statistics and the Industrial Conference Board give figures for exactly the same thing, and since the question as to which gives the more nearly correct result is important, it seems desirable, in place of a mere technical description of the Board's index number, to compare the two index numbers as to result and method.

The difficulty in making such a comparison is that the dates for which the two index numbers are calculated are not identical. The index numbers of the Bureau have been issued for the following dates: December, 1914, 1915, 1916, 1917, 1918, and June and December, 1919, 1920. The Board's index numbers are for July, 1915, 1916, 1917; June and November, 1918; March, July, and November, 1919; March, July, and November, 1920; and March, 1921. In addition, a monthly estimate of change in the cost of living is made by the Board, but this is subject to revision. Any comparison of the two series must assume, therefore, that changes are continuous between the dates for which the numbers are calculated. The simplest assumption is that the change between any two dates has been by a uniform amount each month. This assumption may not be valid for any single period, but for the whole time there is a strong probability that it is substantially correct.

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* *War Time Changes in the Cost of Living*, Research Reports Nos. 9, 14, 17, National Industrial Conference Board.

Changes in the Cost of Living, Research Reports Nos. 19, 25, 28, 30, 33, 36, National Industrial Conference Board.

Comparisons are made with certain studies of the United States Bureau of Labor Statistics.

When the two index numbers are studied in this manner, it appears that the Board's index number shows smaller changes in the cost of living over the initial period at every date than the Bureau's index number. Until August, 1918, the difference was not large, at no time exceeding five points; but since that date it has been between ten and fifteen points. In November, 1920, for example, the Board's index number stood at 193.1, while the index number of the Bureau for December, 1920, was 200.4. According to the monthly estimate issued by the Board, the index number for December was 190.

The first explanation of this disagreement which suggests itself is the difference in the bases from which the changes are calculated. The Board's index number shows changes from July, 1914, but the base of the index of food prices—a very important part of the total—is the average of food prices for 1913. The Bureau's number has the year 1913 as its base. But this difference is not very important. The Bureau's index number shows an increase of only 3 per cent in the cost of living from 1913 to December, 1914, and over half of this increase was due to changes in food prices. The cost of living in July, 1914, was probably, therefore, not more than 1 or at most 2 per cent above the average for 1913. Obviously, the large disagreement between the two index numbers since 1918 cannot be explained by the difference in bases, although this difference lessens somewhat the amount of disagreement to be explained.

Another explanation of the disagreement has been advanced by Dr. Hugh S. Hanna in the October, 1919, number of the *Monthly Labor Review*. Dr. Hanna's article was written before the Bureau began to publish its index number for the United States as a whole, but he uses the same data in compiling his index number. According to his theory the disagreement is due to the fact that the earlier cost-of-living studies made by the Bureau were entirely in ship-building cities, while the Board's studies covered a much larger number of cities. He estimated from studies made by the Bureau in 1918 that prices had increased from January 1, 1917, 12 per cent less rapidly in other cities than in the ship-building cities. When allowance was made for this fact, the two series agreed fairly well. This explanation cannot, however, be applied with much force to the index numbers of the Bureau after December, 1917, for since that date the Bureau has used data for a number of other cities in addition to the material for the shipbuilding cities, and it is exactly in this period that the discrepancy between the two index numbers is greatest.

Another possible source of the disagreement is suggested by the differences in the weights given to the groups of expenditure. The Bureau's index number is weighted on the basis of the results of a survey made in twenty-two cities between July 31 and November 30, 1918. The weights used by the Board are averages of the results of a number of private and official budgetary studies made at various dates from 1901 to 1917, weighted according to the number of families covered by the respective studies. Since the most extensive of these investigations was the 1901 study of the Bureau, the weights used by the Board are nearly the same as the figures given by that study. In brief, then, the Board's index number is weighted by a distribution of expenditure found in 1901 and the Bureau's number is weighted by a distribution of expenditure found in 1918.* The two systems of weights are as follows:

PER CENT OF THE TOTAL EXPENDITURE

	Board	Bureau
Food	43.13	38.2
Clothing	13.21	16.6
Shelter	17.65	13.4
Fuel and light	5.63	5.3
Sundries	20.38	26.4†

It will be noted that in the Board's system of weighting relatively greater importance is attached to food and shelter, while less importance is attributed to clothing and sundries. If the prices in all groups had advanced equally, the system of weighting adopted, obviously, would have been a matter of indifference. On the other hand, if food and shelter had advanced at a more rapid pace than clothing and sundries, or vice versa, a considerable difference in the index numbers would have been attributable to the differences in weighting. As a matter of fact, however, the changes in the prices of the different groups have been of such a compensatory character as largely to nullify the importance of the difference in weighting. Even at the dates where the disagreement due to this cause is greatest, it does not appear to be more than a few points, and it is variable in amount.

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* Neither, of course, is the best system of weighting; the ideal system would be one based on the distribution of expenditure in 1913 or 1914.

† In the Bureau's classification of expenditures, sundries are divided into "miscellaneous," with a weight of 21.3, and "furniture and furnishings," with a weight of 5.1.

It is obvious that none of the differences in construction which have been noted is sufficient to account for the regular, and, since January 1, 1918, fairly large disagreement between the two index numbers. An examination of the index numbers for the component groups of expenditure proves to be a more satisfactory clue. The index numbers for food and fuel and light in the Board's calculation agree with the index numbers for the same groups in the Bureau's calculation. The Board uses the index number for food as calculated monthly by the Bureau. The Board's index number for fuel and light is based on questionnaires sent to a large number of cities. "The changes in the cost of anthracite and bituminous coal are weighted according to their importance for domestic use," and the combined figure for fuel and light is obtained by using a system of weights based on the assumption that "about one-third of the average family expenditure for fuel and light goes for light and about two-thirds for fuel." The Bureau of Labor Statistics has never published any information, as far as the writer is aware, regarding the methods by which it computes its index number for fuel and light. However, since the two index numbers agree fairly well, it is useless for our present purpose to conjecture as to differences in methods.

When we examine the three other groups of expenditure—clothing, housing and sundries—we find not only that the two sets of index numbers do not agree, but that the differences between them are of a fairly regular amount. The index number of the Board for shelter is higher than that of the Bureau for housing, while the index numbers of the Board for clothing and for sundries* are considerably below those of the Bureau. The sum of the differences in the index numbers for clothing and sundries *minus* the difference in the index number for housing, when weighted by the value of these groups in the total cost of living, gives an amount which accounts approximately for the disagreement between the index numbers of the total cost of living.

The differences between the discordant group index numbers are so constant as to suggest fundamental dissimilarities either in material or method. Unfortunately, the information disclosed by the makers of these index numbers is not sufficient to make it possible to probe the question thoroughly. In what follows, therefore, only the most superficial analysis has been made.

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* The Bureau's index numbers for miscellaneous and "furniture and furnishings" have been combined into a single index number, which is here regarded as comparable with the sundries group of the Board.

The index number for shelter used by the Board, as has been said, runs uniformly higher than that of the Bureau for the same expenditure. It is possible to carry the analysis of this index number a step back, since the changes in the cost of housing are given for individual cities by both the Bureau and the Board. When these changes are compared, it becomes clear that the reason for the difference in the index numbers lies primarily, if not entirely, not in the method of averaging the increases in different cities, but in the differences in the amounts of change found by the Board and the Bureau for the same cities. The Board's figures are almost without exception higher than those of the Bureau. For example, the increase in the cost of housing in Philadelphia is estimated by the Board for March, 1921, as 51–60 per cent, while the Bureau's estimate for December, 1920, is 38 per cent and for May, 1921, 44.2. In the absence of detailed statements of the methods employed in collecting the material, no explanation of these differences can be made. The method employed by the Board is to send questionnaires to "real estate boards, brokers, chambers of commerce, social organizations and individuals." The exact form of the questionnaire is not revealed, but from the miscellaneous character of the sources of information it may be presumed that an estimate of the amount of change is requested. The answers to such a questionnaire probably exaggerate the changes in rents. If a real estate broker is asked how much rents have risen or fallen in a given period, he is likely to place too much weight on the changes which have come to his attention and insufficient weight on the cases in which no changes have occurred. If the Bureau of Labor makes an actual study of the books of real estate agents, its figures for changes in rent are probably better than those of the Board.

There are two important differences in the methods used by the Board and the Bureau in making their index numbers for the cost of clothing. In the first place, the Bureau averages changes in the prices of various articles of clothing to find the change in the cost of clothing for each city, and then averages the city index numbers to find an index number for the United States as a whole, while the Board averages directly the returns from a number of dealers in different cities. The Board draws its quotations from a larger number of cities. Secondly, and a more likely cause of the disagreement, is the difference in the systems of weights. The Bureau's index number for clothing is unweighted, while that of the Board is weighted on the basis of a clothing budget. In the absence of the detailed price figures used by the Bureau, it is impossible to establish the effect of this difference, but the presumption is strongly in favor of a weighted index number of clothing.

As has already been noted, the group of expenditures which is called sundries by the Board is divided by the Bureau into two groups known respectively as miscellaneous and furniture and furnishings. The index number for sundries is made by the Board from prices of "car fare, doctor's fees, church contributions, organization dues, insurance, reading, amusements, candy, soft drinks, tobacco, furniture and furnishings, and household supplies." But only rough estimates of changes in the prices of these articles are made, and the weight assigned to each of these articles or groups of articles is not stated. The Bureau of Labor Statistics does not publish the list of articles included in the miscellaneous and furniture and furnishings groups, nor the system of weights employed. Even conjecture as to the cause of the disagreement is, therefore, impossible.

In what has been said above, attention has been directed to the disagreement of the two index numbers. From a wider point of view, their correspondence is more important. For many years the question of devising a more adequate measure of the cost of living than the index number of retail food prices has been discussed, and the opinion has frequently been expressed that the difficulties to be faced were insuperable. When differences in material and method are taken into account, the substantial correspondence of the two index numbers here compared is the best proof that such a measure is practicable. Neither the index number of the Board nor that of the Bureau is the last word in measures of the cost of living, but they possess the great merit of having demonstrated the practicability of such measures. The index number of the Board has contributed materially to establishing the influence of measures of change in the cost of living in wage determinations. The more frequent appearance of the Board's index number has facilitated the use of such measures of change, and its general correspondence with the index number of the Bureau has greatly enhanced the prestige of such measures. The Board has done a useful piece of work and it is to be hoped that the maintenance of an index number of the cost of living will be a permanent part of its work.

ON THE BEST FORM OF INDEX NUMBER

By Royal Meeker, *International Labor Office, Geneva*

There is undoubtedly at the present time a keener interest in price fluctuations and a better understanding of index numbers as a measure of such fluctuations than ever before. The importance of measuring price changes accurately and promptly makes the consideration of the methods employed in constructing index numbers especially timely. It is a matter of keen regret to me that distance and the duties of my new office made it impossible for me to attend the eighty-second annual meeting of the American Statistical Association, and to hear Professor Irving Fisher's views on the best form of index number and the illuminating discussion which followed. It is not clear from the brief summary of Professor Fisher's paper published in the March issue of the QUARTERLY whether he considers the mathematical formula for computing an index number of equal, greater, or less importance than the other characteristics of index numbers which he mentions. My own experience in recalculating the wholesale and retail price indices of the United States Bureau of Labor Statistics convinced me that the particular mathematical formula to be used in computing index numbers, while not a trifling matter, is of minor importance compared with the commodities to be selected for inclusion in the index, their prices and their quantities to be used as weights. Although the range of my experimentation was rather limited, it did not seem to me that it made much difference what machinery of calculation was used as long as the raw materials from which the index numbers are made is of good, sound, dependable quality. To borrow from Professor Fisher's picturesque and forcefully descriptive vocabulary, "it matters but little what mathematical formula we use in computing the indices of p's and q's as long as we mind our p's and q's." If Professor Fisher or any one else had convinced me in 1914 of the superiority of the geometric mean over the weighted arithmetic mean or "price aggregate" method of computing index numbers of wholesale prices, I would cheerfully have discarded the arithmetic mean and adopted the geometric mean. I would have done so notwithstanding the fact that a "price aggregate" is easily comprehensible by any one of ordinary intelligence as the cost of a given bill of goods, whereas the geometric mean is understandable only by those who have a pretty clear comprehension of mathematics.

I am quite puzzled by the rather bizarre mathematical formula employed by Professor Fisher to illustrate the defects of the weighted arithmetic mean. Certainly no one advocates using such a double system of weighting today. The compilers of the old index numbers published by the British Board of Trade made use of weighted price relatives, but these price relatives were weighted by constants representing the estimated money values of each commodity in the base year or period. The mathematical method employed in computing the old Board of Trade index numbers was sound enough. The defects in these indices were to be found in just those things which are left out of Professor Fisher's discussion, viz., the character and number of the commodities included, the sources of the "prices," and the quantities used as weights. I do not wish to be understood as undervaluing mathematical precision in calculating index numbers, but I feel sure that even the absurd double weighted mathematical formula given in the illustration by Professor Fisher could be applied to any series of index numbers which includes all important representative commodities without very much changing them. My experience in recalculating the Bureau of Labor index numbers of wholesale prices convinces me that this would prove to be the case. What could be more absurd than the wildly erratic weightings contained in the so-called "unweighted" index number, in which the prices of nutmegs, pig iron, wheat, 1-inch augurs, cotton, quinine, potatoes, chisels, and pork all had equal influence upon the general level of prices? Certainly it was natural that I should feel qualms of misgiving during the process of transforming the old "unweighted" index numbers into the new "weighted" ones, especially as I was obliged to do some most heroic "estimating" in arriving at some of the quantity weights to be used. I shall deal with the problems of quantity weights later. Yet the discrepancies between the old Bureau of Labor index and the new are not very great, not nearly so great as I expected. Professor Mitchell, who advised and assisted me throughout in the recalculation, was also astonished, I think, that greater differences were not shown. In fact the differences were so slight that I was led to remark that no matter what the statistician does with an index number, he is always bound to come out right. This seems scarcely an exaggeration as long as the index contains all the important representative commodities and the statistician is honest and does not purposely try to make the index "point a moral or adorn a tale."

It seems to me that Professor Fisher is trying to perform a miracle, or at least to accomplish the impossible. Indices, like all human devices, are strictly limited in their uses and applications. While I was commissioner of labor statistics, I received communications beseeching me, as official price compiler and controller, to use my authority to bring prices down. Some persons apparently thought that prices were rising because the index numbers were increasing, and that all that was necessary to bring down prices was to decrease the index number. How very fortunate for the compilers of index numbers that prices cannot be controlled by index numbers! It is, perhaps, not so fortunate that index numbers are so limited in their usefulness. A price index number can never show anything but variations in prices, and even shown in the census of production of 1907, the latest figures available. Mr. Flux expressed the opinion, however, that accuracy in weights is essential in an index computed by the method of the arithmetic mean, which is the method used in computing the United States Bureau of Labor Statistics index and which is recommended by Professor Fisher for the proposed index in all calculations up to the final one. It would surely seem that if quantity weights are to be used at all they should be as accurate as possible. I therefore think it would be quite sufficient to revise the quantity weights every ten years, as soon as the decennial census figures become available.

Even more important than accuracy in the quantity weights are accuracy and representativeness in the price quotations. The prices used by the Bureau of Labor Statistics may be criticised on the ground that they are not homogeneous since they are obtained from different sources. Of 371 quotations in 1919, 203 are obtained from trade journals, 152 from manufacturers or sales agents, 13 from boards of trade, and 3 from federal or state bureaus. While commissioner of labor statistics, I tried to secure all quotations direct from jobbers and wholesalers, but with the slender resources of the Bureau it was impossible to discontinue the use of the trade journals. All prices were thoroughly checked and revised, however, and it can be said with confidence that they are the best obtainable unless much more money is to be spent than has ever been spent on wholesale prices by the Bureau. It may be worth stating, in view of the charges of extravagance in government expenditures, that only two employees working only part of the time on wholesale prices have kept this work up to date, so that the indices for the nine groups of commodities and for all commodities are issued to the press, and to all who desire them, each month for the preceding month. It is very desirable that more money should be spent in securing absolutely trustworthy *wholesale* prices as distinct from either *manufacturers'* prices or *trade journal* prices. The Federal Trade Commission, the Federal Reserve Board, or some other federal agency should take over the task of gathering these price statistics. It is important that *manufacturers'* or *producers'* prices should be gathered as well as *wholesale* prices and that index numbers be computed for both series of prices.

The wholesale prices of the Bureau of Labor Statistics are open to criticism in that too many quotations are secured from the big cities. Of 32 quotations of farm products, 19 are obtained from Chicago; of 100 food products, 26 are from Chicago and 42 from New York; of 21 fuel and light, 9 are from New York; of 43 metals and metal products, 20 are from New York and 12 from Pittsburgh; of 32 lumber and building material, 23 are from New York; of 18 chemicals, all are from New York; of 23 miscellaneous, 12 are from New York; of a total of 371 quotations, 56 are from Chicago and 132 from New York. Of course New York and Chicago are the largest markets in the country, and the trade journals and selling agencies are concentrated in these great centers; but it is obvious that prices to be representative should be scattered more widely. This means expending more money than Congress appropriates to the Bureau of Labor Statistics.

In my view the best way to achieve the "best index number" is first, to secure more trustworthy and more representative prices from (1) *producers* and (2) *jobbers* and *wholesalers*, and secondly, to obtain more accurate statistics and estimates of quantities of goods produced, imported, exported, and consumed. It is especially necessary that the estimates made by me in 1914 of the quantities of goods of various kinds entering into *exchange* be carefully checked and revised in the light of more recent and more detailed information. It is desirable that several different kinds of index numbers be prepared by the federal agency having in charge the collection of producers', jobbers', and wholesalers' prices and the compilation therefrom of price indexes. Much more time and effort should be devoted to the subject of producers' and wholesale prices than has been devoted to them in the past. When the quantities and the prices are thoroughly satisfactory I think it will make but little difference what mathematical formula is used in calculating the index numbers.

THE BUSINESS INDICES OF THE *FRANKFURTER ZEITUNG*

It has long since been the policy of the *Frankfurter Zeitung* to publish original statistics with regard to economic conditions in Germany. These statistics are of particular interest at the present time because of the chaotic condition of the German credit and currency situation.

The most interesting of the statistical series which are now compiled and published by this journal are its index numbers on wholesale commodity prices, securities' prices, wages per hour in Frankfurt, and foreign exchange values, its compilations of bankruptcies, and its compilation of securities issued in Germany. All these statistics appear in the current numbers of the paper. The index of securities prices is published weekly; the wholesale price index and the statement of securities issued appear at the first of each month; the bankruptcy figures are published quarterly, while the figures on wages have appeared only once (in the second edition of May 22, 1921), and the foreign exchange figures only once (on February 26, 1921). The index numbers among these series have also been published from time to time within the last six months in pamphlet form called, in its first edition, "Die Indexziffern der Frankfurter Zeitung," and thereafter "Die shown in the census of production of 1907, the latest figures available. Mr. Flux expressed the opinion, however, that accuracy in weights is essential in an index computed by the method of the arithmetic mean, which is the method used in computing the United States Bureau of Labor Statistics index and which is recommended by Professor Fisher for the proposed index in all calculations up to the final one. It would surely seem that if quantity weights are to be used at all they should be as accurate as possible. I therefore think it would be quite sufficient to revise the quantity weights every ten years, as soon as the decennial census figures become available.

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Indexzahlen der Frankfurter Zeitung." Each edition bears upon its cover the name of Ernst Kahn, and opens with an introduction by him.

The method by which these indices are constructed is very simple. In each case the index represents an unweighted arithmetic average of relatives, using quotations as of January 1, 1920, as a base. In introducing the wholesale price index number, the author says:

> "Unfortunately up to this time Germany has lacked a good wholesale price index. We hereby attempt to give one. In the construction of the commodity price index of the *Frankfurter Zeitung*, the investigations which Professor Irving Fisher sets forth in his two great books, 'The Purchasing Power of Money' (which was published in German by G. Reimer [Berlin] in 1916) and his newest work 'Stabilizing the Dollar' have been taken into account along with our own information on the subject. The layman will demand as the first requisite for a good commodity index number that in the assembling of the quotations each commodity shall be valued or weighted according to its importance in industry. Fisher's investigations show that this is not necessary. The following graph taken from Fisher's work makes that evident; we see that computation with or without the use of quantity weights gives parallel curves." (At this point the graph, which appears on page 3 of "Stabilizing the Dollar," is reproduced.) "It would take us too far afield to set forth here the theoretical grounds of this noteworthy discovery, but these investigations of Fisher's have given us the courage to attempt to carry out our long cherished desire to compute a commodity index number. The difficult question of placing the individual commodities according to their importance had always kept us, before this, from undertaking the task."

The commodity index of the *Frankfurter Zeitung* is, however, roughly weighted by the choice of commodities included. In the index as it now stands* there are seven quotations for chemicals, three quotations for coal, and five for iron and steel products. Raw cotton, cotton yarn, and cotton cloth are all represented, as are hides, leather and shoes; flax and linen yarn are both included, and raw jute and jute bagging, but wool and silk are represented by only one quotation apiece.

This index contains 77 commodities, divided into four groups as follows:

Group I. Wheat, rye, oats, barley, corn, potatoes, beans, peas, lentils, rice, eggs, meat, lard, margarine, butter, milk, condensed milk, powdered cocoa, coffee, sugar, beer, tobacco, hay, straw, hops, wine.

Group II. Raw cotton, scoured South-German sheep's wool, silk yarn (organzine), cotton yarn, cotton cloth, artificial silk, flax, linen yarn, raw jute, jute bagging, twine, hides, leather, shoes, rubber.

Group III. Non-coking bituminous coal, coking coal, foundry coke, Rhenish lignite, machine pressed peat, iron ore, pig iron, rolled plates, steel scrap, iron bars, copper, tin, zinc, lead, aluminium, nickel, silver, gold.

Group IV. Machine oil (refined), petroleum, benzine, benzol, newsprint paper, cement, bricks, salts of potash, sulphate of ammonia, lime nitrogen, kainite, brown leather dye, alcohol, timber, firewood, calcium carbide, saltpetre, coal tar oil.

The "peace index" (*i. e.*, the index number applying to the middle of 1914) and that for January 1, 1920, are the only ones, however, which include all the commodities noted. In every other month it has been impossible to get a complete list of quotations. It is, in fact, remarkable, considering the chaotic state of German prices, that omissions have not been more numerous.

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* See "Die Indexzahlen der Frankfurter Zeitung," 4th edition, dated May 17, 1921.

WHOLESALE PRICE INDEX OF THE *FRANKFURTER ZEITUNG*

	Foods, etc.	Textiles, leather, etc.	Minerals	Miscellaneous	All commodities
Peace index	11.38	3.67	7.15	12.0	9.23
1920					
January 1	100	100	100	100	100
February 1	119	153	145	123	131
March 1	126	165	163	147	147
April 1	135	151	135	170	146
May 1	134	119	133	170	156
June 1	128	98	110	197	134
July 1	146	94	111	195	136
August 1	149	97	112	194	141
September 1	150	103	118	193	144
October 1	153	108	124	191	146
November 1	165	111	120	199	152
December 1	177	99	117	195	153
1921					
January 8	154	97	120	189	148
February 5	144	92	113	183	136
March 5	137	87	111	182	131
April 2	136	79	115	180	130.1
May 7	133	78	112	194	131.8
June 4	127	70	109	196	128
July 2	144.5	79	115.3	190.6	135.4

The statistics used in the index number of wages per hour paid in Frankfurt represent 23 different trades. It was possible, however, to obtain comparable rates in 1914 for only 9 of these trades, so that the index number uses January 1, 1920, as a base, and gives no figures for 1914. It is computed by averaging the monthly relatives obtained for each industry. The figures do not take into account unemployment and hours of labor in the various industries represented and do not, therefore, give any indication of the actual earnings of wage-workers in Frankfurt.

The following table presents the wage index of the *Frankfurter Zeitung:*

FRANKFURT-AM-MAIN

	Index number of hourly wages
1920	
First of January	100
February	112
March	122
April	146
May	168
June	169
July	184
August	186
September	186
October	188
November	198
December	200
1921	
Beginning of the year	203
First of May	219

The following table gives the index numbers for wages in the industries for which 1914 rates could be obtained:

RELATIVE WAGES PER HOUR IN FRANKFURT-AM-MAIN*
(JANUARY 1, 1920=100)

Industry	1914	January 1, 1920	July 1, 1920	Beginning of 1921	May 1, 1921
Building	22	100	195	226	233
Metallurgical	22	100	206	230	230
Soap	16	100	190	208	221
Food	16	100	169	211	257
Shoe	22	100	157	174	222
Decorating	22	100	203	242	265
Rubber	21	100	238	255	272
Chemical	22	100	250	279	291
Mining	17	100	159	180	200

* In the majority of these cases the increase in wages seems to have been approximately the same as the increase in the cost of living. According to the cost of living index for Frankfurt compiled by Dr. Elsas, living costs in that city have risen from 26.5 on January 1, 1914, to 280 in May, 1921 (using April 1, 1919, as 100). In dealing with these figures, it should be remembered that living costs have been kept as low as they are by the government regulation of rents and of the prices of some foodstuffs.

It seems regrettable that none of the index numbers of the *Frankfurter Zeitung* is weighted. It is particularly unfortunate in the case of the index of foreign exchange values, where an unweighted arithmetic average is especially unreliable. In this case, however, it would be particularly difficult, as Herr Kahn points out, to obtain the data necessary for the compilation of weights, since the most recent statistics giving German trade by countries apply to the period from January through August, 1920. He therefore heads his paragraphs explaining this index, "Der Versuch eines Valutenindex" ("A Tentative Foreign Exchange Index"). The quotations included are those on eleven countries: the United States, England, France, Holland, Switzerland, Sweden (as the greatest of the Scandinavian countries), Italy, Spain, Belgium, German-Austria (as the representative of the former Austro-Hungarian territory), and Roumania (as the country in the Balkans of the greatest importance to Germany at the present time). The following table gives the figures arrived at by averaging the relatives of quotations on these countries, using the par value of the mark as 100:

GERMAN FOREIGN EXCHANGE INDEX
(Par value of the mark=100)

1920	
January	13.4
April	10.1
May	7.3
June	18.3
July	18.2
August	17.2
September	15.5
October	13.1
November	10.5
December	11.7
1921	
January	11.1
February	11.6
March	12.2
April	11.9
May	10.8

The index number of securities prices (the Bourse index) contains quotations of 25 shares and 10 bonds. Its fluctuations are summarized in the following table:

INDEX NUMBERS OF SECURITIES PRICES

	10 Bonds	25 Shares	Total
1919			
September 1	97	79	87
1920			
January 1	100	100	100
February 1	120	139	*137
March 1	145	*158	*157
May 3	114	*135	133
June 1	105	110	109
July 1	106	119	117
August 2	106	144	140
September 4	*122	152	*148
October 2	122	*165	160
November 6	143	*181	177
December 4	136	184	178
1921			
January 8	132	*202	194
February 5	121	165	159
March 5	118	*158	153
April 2	117	169	163
May 7	120.5	*166	*161
June 4	120.6	172	166
July 2	125	188	181

* Corrected in accordance with the aggregate prices published by the *Frankfurter Zeitung*. In these cases the index number published does not agree with the corresponding absolute figures. The deviations are in most cases very slight.

FAITH M. WILLIAMS

Federal Reserve Board

ON PROFESSOR MORITZ' METHOD FOR COMPUTING FREQUENCY PERCENTAGES

In a recent article* Professor Moritz sets forth a new method for computing frequency percentages. The same method may be applied in computing the percentages that the frequencies are of N. In certain psychological experiments each of N individuals attempts all of a number of problems, and the frequencies of success or failure for each problem are

$$f_1, f_2, f_3, \quad . \quad . \quad . \quad , f_n.$$

It is required to compute the percentages

$$P_k = 100 f_k / N, \ k = 1, 2, 3, \quad . \quad . \quad . \quad , n.$$

The two steps in the method analogous to those of Professor Moritz will be:

(1) Replace the frequencies f_k by proportional numbers f'_k, the factor of proportionality being N'/N, where N' approximates 100.

(2) Distribute the difference $D = 100 - N'$ over the numbers f'_k in accordance with the formula $\Delta f'_k = f'_k \,.\, D/100$, where $\Delta f'_k$ is that portion of D which falls to f'_k.

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* "On a New Method of Computing Frequency Percentages," QUARTERLY PUBLICATIONS OF AMERICAN STATISTICAL ASSOCIATION, March, 1921.

Since $N'+D=100$ it follows that

$$P_k=f_k\frac{(N'+D)}{N}.$$

The approximation P'_k is obtained by multiplying the small quantity D/N by $N'/100$, the last ratio approximating unity. Thus,

$$P'_k=f_k\left(N'/N+\frac{DN'}{100N}\right) \text{ or}$$

$$P'_k=f'_k+\Delta f'_k.$$

It may be noted that the error

$$P_k-P'_k=f'_k\frac{(100-N')^2}{100N'}.$$

The relative error is given by the expression

$$R=\left[\frac{100-N'}{100}\right]^2.$$

The following problem illustrates the method:

FREQUENCY AND PER CENT FAILING

k	fk	$f'k$	$\Delta f'k$	$P'k$
1.	4	2.4	—.02	2.38
2.	7	4.2	.03	4.17
3.	15	9.0	.07	8.93
4.	28	16.8	.13	16.67
5.	35	21.0	.17	20.83
6.	43	25.8	.21	25.59
7.	64	38.4	.31	38.09
		117.6 + —.94 = 116.66 (check)		

Suppose $N=168$. Choose $N'/N=.6$ so that $N'=100.8$. (1) $f'k=.6fk$. (2) $100-N'=-.8$, $\Delta f'k=-.8\%$ of $f'k$.

It may be noted that the advantages of the above method are limited unless N'/N is chosen so as to give a simple ratio. In the above example all of the calculations may be done mentally.

KARL J. HOLZINGER

ANALYTICAL SUMMARY OF THE NEW ZEALAND CENSUS OF 1916*

In a recently issued report the principal facts of the New Zealand Census of 1916 are summarized and analyzed. The tabular parts of the census have already been issued in separate bulletins. Among the features of this volume are a historical sketch of New Zealand census takings and a study of family statistics, including conjugal condition and fertility, dwellings and households.

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* *Report on the Results of a Census of the Population of the Dominion of New Zealand taken for the Night of the 15th October*, 1916. Malcolm Fraser, Government Statistician, Wellington. By authority: Marcus F. Marks, Government Printing, 1920.

The first general census of New Zealand took place in December, 1851, although since 1841 annual returns of population for the various settlements had been made by local resident magistrates. Since that date censuses have been taken at least as often as twice in a decade, and in the sixties and seventies three times in a decade. The census enumeration has always been of the de facto population.

With regard to the chapters on conjugal condition and fertility, an interesting feature is the combination of the results of the census with those of the registration statistics of births. Among others, tables are presented showing relative ages of husbands and wives at the date of the census, and annual birth-rates for each combination of ages; ages of wives in connection with the number of issues born and the number living; average number of children to married women of different ages; percentages of married women of different ages who at the date of the census were childless or had borne one or more children; and the average number of children to marriages of different durations.

The section on dwellings and households contains interesting material. Households are classified by sex and marital condition of the head of the household, by number of breadwinners, by number of non-breadwinners, by number of children under 14 years of age; the principal findings have already been discussed in a previous note.

Besides these subjects chapters are devoted to the findings with regard to age, birthplace, length of residence in New Zealand, religion, education, infirmity, and occupation; a special chapter is devoted to a study of race aliens, and appendices discuss the censuses of Maoris and of the outlying islands.

Robert M. Woodbury

MISCELLANEOUS NOTES

Circulation Inquiry on the Monthly Review of the Federal Reserve Bank of New York. The Federal Reserve Bank of New York has just completed a tabulation of the returns from a circular letter sent to the persons on the mailing list for its *Monthly Review of Credit and Business Conditions*. The *Review* has had a circulation of about 50,000. More than 15,000 copies are sent to member banks, but the remainder are sent to a mailing list secured in a somewhat wholesale fashion by a directory company. The recent circular letter was sent to 34,000 persons and asked whether they wished to continue to receive the publication and also what features of the report the readers found most interesting. Replies were received from 17,000 persons, of whom 90 per cent wished to continue to receive the *Review*. The negative replies were largely due to retirement. The following table shows the percentage of the persons replying affirmatively who mentioned different items as interesting.

Articles	*Percentage*
Credit Conditions	60.4
Prices	48.2
Wages	46.6
Securities	45.9
Banking	43.6
Money Market	42.4
Cost of Living	39.9
Employment	37.4
Production	33.8
Foreign Trade	33.7
Federal Reserve Banks	28.3
Retail Trade	27.7
Building	23.8
Particular Industries	10.7
Other	6.6

As was to be expected, the choice of persons in different professions varied considerably. Merchants and manufacturers were most interested in the general survey of credit conditions. College professors, statisticians, and other professional persons were most interested in prices. Bankers were naturally most interested in banking. Lawyers were most interested in securities. Manufacturers gave their second vote to wages. A great many of those who sent answers made special comment on one feature or another of the *Review*. The feature most frequently mentioned was the diagrams which are included in the *Review*.

The National Bureau of Economic Research. During the past twelve months, the National Bureau of Economic Research has been engaged in estimating the income of the people of the United States for each of the years since 1909. The director of research, Wesley C. Mitchell, has been assisted by three staff members, each working on a separate phase of the inquiry. Oswald W. Knauth has been approximating the total income by summating the amounts reported to the income tax authorities and the estimated income falling outside the taxable field. Willford I. King has been attempting to reach the same goal by estimating the value product of each of the important branches of industry, using the census as the principal source of material. Frederick R. Macaulay has been working on the problem of ascertaining the approximate number of income recipients falling into each income class. It is expected that preliminary estimates of totals will be in the hands of the directors of the Bureau in the near future, and that the analysis for the last decade will be ready for publication late in 1921. After the completion of this study, it is planned to investigate the causes and mechanism of business cycles. The Bureau expects to coöperate with other scientific workers interested in the same line of research. As the Bureau will confine itself to the field of description and explanation, it will not compete with organizations devoted to forecasting.

Industrial Relations Conference. An Industrial Relations Conference, authorized by Governor William C. Sproul of Pennsylvania, is being arranged by Dr. Clifford B. Connelley, Commissioner of the Department of Labor and Industry, Commonwealth of Pennsylvania, to be held at Harrisburg, Pa., October 24 to 27. This conference will include the features of the Welfare and Efficiency Conferences and Safety Congresses of other years. The main topics to be discussed will include industrial waste, industrial coöperation, industrial publicity, industrial education, women and children in industry, and the medical supervision of industry.

Conferences on Statistical Subjects. The Department of Statistics of the Federal Reserve Bank of New York has been holding a series of weekly conferences on statistical subjects. Among the speakers were Dr. H. Parker Willis, Federal Reserve Board; Professor Irving Fisher, Yale University; Dr. Willford I. King, Bureau of Economic Research; Governor Benjamin Strong, Federal Reserve Bank of New York; and Dr. Wesley C. Mitchell, New School for Social Research. The conferences have been suspended for the summer, but they will be resumed in the fall. These meetings are open to statistical workers in New York City.

A Statistical Bureau Suggested for the British Empire. At the conference of Prime Ministers of the British Empire, which was held during June in London, the question of the establishment of a British Empire Statistical Bureau was under discussion, on report by the Statistical Conference held in 1920. An Inter-departmental Committee on Statistics for the United Kingdom has recently presented a report on the Organization of Official Statistics in Great Britain.

Committee on Nomination of Officers for 1922. In accordance with Article IX of the Constitution, the president has appointed a committee to nominate officers for election at the annual meeting, to be held in Pittsburgh in December next. Twelve or more regular members or fellows may make nominations by submitting signed petitions to the nominating committee at any time after the appointment of the committee and up to the time of the annual meeting.

The committee is composed of Walter F. Willcox, Cornell University, chairman; Charles E. Baldwin, United States Bureau of Labor Statistics, Washington, D. C.; and F. Leslie Hayford, General Motors Corporation, New York City.

Annual Meeting of the Statistical Association. The Association will hold its annual meeting in Pittsburgh on December 27–29 inclusive. The American Economic Association meets at the same time and place. Suggestions with reference to this meeting addressed to the secretary of the association will be placed in the hands of the Program Committee. Program announcements will be mailed to each member.

Special Meeting of the Association. The Committee on Business Research held a meeting on June 17 at the Machinery Club in New York City. Charles C. Parlin, head of the Department of Commercial Research of the Curtis Publishing Company, gave the principal address, on the topic, "Commercial Research and Business Policies." Keen interest was shown in the subject, as was indicated by the attendance of about 120 members and their guests, and by the general discussion which followed the main paper.

Dr. Joseph A. Hill has been made assistant director of the census; his appointment was confirmed by the Senate on July 13, 1921.

Dr. W. Randolph Burgess, who was associated with Colonel Leonard P. Ayres in the Statistics Branch of the General Staff of the Army, and in the statistical work of the Russell Sage Foundation, is now with the Statistics Department of the Federal Reserve Bank of New York as chief of the Reports Division. He has in charge the editing of the *Monthly Review of Credit and Business Conditions.*

Mr. G. H. Knibbs, commonwealth statistician of Australia, has been appointed director of the Australian Bureau of Science and Industry.

Mr. G. Findlay Shirras, director of statistics of India, has been appointed director of the new Labour Office, in the Secretariat, Bombay, India.

Dr. John J. Tigert, formerly professor of psychology in the University of Kentucky, has been appointed United States commissioner of education.

The Federal Reserve Bank of New York has taken on for special summer work in the Department of Statistics instructors and graduate students from a number of colleges and universities. The list includes the following names:

M. J. Williams	Harvard Graduate School of Business
B. B. Smith	" " " " "
I. G. Richardson	" " " " "
C. Rogeberg	" " " " "
E. R. Lilley	New York University
F. T. Taylor	Tuck School, Dartmouth College
J. D. Brown	Princeton University
C. A. Warburton	Cornell University
Muriel Bowden	Brearley School, New York City
Clara Eliot	Columbia University

Mr. F. B. Rankin, Mr. Samuel Michener, and Miss Minetta Goetz, formerly students in the statistical and actuarial courses at the University of Michigan, are now employed in the Statistical Department of the American Telephone and Telegraph Company in New York City.

NEW MEMBERS ELECTED SINCE MAY 1

Duncan, C. S., consulting economist, Southern Wholesale Grocers Association, New York City

Ellis, George G., statistician, Public Service Dept., Merchants National Bank, Los Angeles, Calif.

Gebhart, John C., director, Dept. of Social Welfaré, A. I. C. P., 105 E. 22nd St., New York City

George, E. E., Valuation Division, City Transit Office, Philadelphia, Pa.

Gunnarson, Arthur B., School of Business, University of Minnesota, Minneapolis, Minn.

Holzinger, Karl J., School of Education, University of Chicago, Chicago, Ill.

Kile, Kathryn L., Cost and Circulation Analyses, Outer's Book Co., Chicago, Ill.
Kolhert, Edward O., industrial engineer, Edison Storage Battery Co., Orange, N. J.
Laidlaw, Walter, research and fellowship secretary, New York Federation of Churches, 200 Fifth Ave., New York City
McEwen, George F., Scripps Institution for Biological Research of the University of California, La Jolla, Calif.
McKenney, William F., U. S. Geological Survey, Washington, D. C.
McKernan, John F., Western Electric Co., 195 Broadway, New York City
May, Grace I., Corporation Buying Dept., Hakey Stuart & Co., Chicago, Ill.
Mills, Frederick C., School of Business, Columbia University, New York City
Milne, Frank D., American Tel. & Tel. Co., 195 Broadway, New York City
Nicholson, S. L., asst. to the vice president, Westinghouse Electric and Manufacturing Co., East Pittsburgh, Pa.
Peirce, Mary F., International Accountants Society, Chicago, Ill.
Piper, G. D., asst. auditor, Westinghouse Electric and Manufacturing Co., East Pittsburgh, Pa.
Ponce de Leon, Jose M., census inspector for the Mexican Federal Government, Chihuahua, Mexico
Rehfuss, John F., Federal Reserve Bank, Philadelphia, Pa.
Sealy, Maria P., Planning Dept., R. H. Macy & Co., New York City
Thorp, Willard L., Dept. of Economics, Amherst College, Amherst, Mass.
Weeks, Estella T., Research Dept., Hoggson Bros., 485 Fifth Ave., New York City
Widdemer, Kenneth D., American Red Cross, 119 W. 40th St., New York City
Willis, H. Parker, director, division of Analysis & Research, Federal Reserve Bank, New York City

REVIEWS

Principes de Statistique Theorique et Appliquée. By Armand Julin. Paris: Albert Dewit. 1921. xxiii, 712 pp.

This work on statistical method is more complete than any similar treatise in English. It begins with a review of the development of the science and then proceeds with the discussion of the principles involved in the usages of present day statisticians. Little effort is made by M. Julin to develop new methods, but he not only attempts but succeeds most admirably in explaining the philosophy underlying the principal processes utilized by statisticians. He compares and criticizes the methods that they follow, and makes clear his reasons for selecting those modes of procedure which he believes to be best adapted to specific classes of problems. In this criticism he shows marked familiarity with the writings of both English and American statisticians.

The book is so voluminous that it seems better adapted for service as a general reference work or as a guide for advanced students than as a text for beginners.

Most of the formulae developed are elementary in nature, hence the non-mathematical student of statistics can understand the majority of them without difficulty.

In general, the author follows the customary terminology, but in a few instances he introduces innovations. For example, he uses the term *covariation* instead of *correlation* to signify any similarity in the fluctuations of two variables. He advocates this procedure because it makes no assumption that the two variables are in any way dependent upon each other, an implication which many statisticians believe to be inherent in the word *correlation.* Despite the admirable desire for accuracy evinced in this respect, it seems to the reviewer that M. Julin has failed to distinguish clearly between the two related but entirely dissimilar ideas represented respectively by the coefficient of correlation and the ratio of variation. It must be said, however, that in failing to emphasize this distinction he is by no means alone.

Although oversights occasionally occur, they are so rare that they stand out as contrasts to the accuracy characterizing the work as a whole. The reasoning is lucid and logical and the style is both simple and pleasing.

This book is decidedly more complete than most similar studies and compares favorably in clarity and definiteness with any of the previously existing works on statistics that have come to the attention of the reviewer.

Willford I. King

Enquiry into Production. International Labour Office. London: Harrison & Sons. 1920. 188 pp.

This Introductory Memorandum is a remarkable publication. Unfortunately, its extraordinary qualities lie in its defects. It is inadequate, unintelligent, un-discriminating, at points even slovenly. Its general deficiency can only be appreciated from first-hand acquaintance; a brief review cannot hope to convey a clear impression of the publication's offences. But some account of the Memorandum seems desirable, especially since its appearance raises serious questions concerning the future work of the International Labour Office.

The Memorandum opens with a report of the discussion which led the Office to undertake the *Enquiry into Production*. Apparently the investigation had its origin in a consideration of the effects of the eight-hour day upon the volume of production. Discussion of this specific issue gradually widened to include all factors contributing to the "crisis of underproduction." Finally, at its Genoa meeting in June, 1920, the Governing Board of the Office ordered "an enquiry into industrial production throughout the world, considered in relation to conditions of labour and the cost of living."

Acting in pursuance of the Board's resolution, the Office conceived its commission to be: "(1) to ascertain the actual facts as regards production and prices; (2) to determine the essential factors which explain the facts; (3) to indicate the solutions which appear to be suggested both by theoretical enquiries and by the facts themselves." No factor relating to underproduction was to be neglected. The task in these dimensions would have seemed Utopian to those in charge had it not been possible to use the results of numerous investigations along similar lines. In the opinion of the Labour Office the task was simply to assemble this information and to supplement it as might be necessary by independent original enquiry.

The Introductory Memorandum is designed to acquaint the public with the general character of the enquiry—"to bring out the spirit of the work and to indicate its main lines and their justification." The extent to which the Memorandum effects this purpose will appear upon a closer examination of the character of the publication.

The Memorandum is really in three sections: a text constituting slightly more than one-half the issue; a schematic plan of enquiry with questionnaires, covering fifteen pages; and a series of fifteen appendices reproducing various documents which, presumably, the Office has found useful in pursuit of the enquiry.

The appendices may be dismissed with a word. They vary widely in length and character. The first is a single-page account of the establishment of the British Government Committee on Increased Production in Industry; the second, a reprint of the questionnaire issued by this Committee. In other appendices questionnaires employed by other investigating bodies are reproduced in full. Appendix XIII reprints the Economic Declaration of the Supreme Council as approved on March 8, 1920; Appendix XII, a report submitted to the Fourth Inter-Allied Commission for Assisting the Disabled in the War, giving statistics relating to the effect of war accidents on the state of employment. Some of these reports furnish valuable material, relevant to an enquiry into production. Others are of doubtful applicability. In general, the wisdom of their inclusion in this Introductory Memorandum may be seriously questioned. It would have been much better to defer their publication until the progress of the Enquiry demonstrated their importance to the ultimate findings.

The text of the Memorandum appears in three parts: Part I: The Facts—the phenomena of physical production; Part II: Explanation of the Facts—the causes of underproduction; Part III: A Critical Study of the Solutions—the means of restoring normal production.

The "facts," submitted in Part I, relate to aggregate amount of production, production per worker, variations in demand, and changes in prices. The only statistics of production actually presented are: (1) those on coal, pig iron, and crude steel, published in the *Monthly Bulletin of Statistics* of the Supreme Economic Council; (2) and the familiar figures on shipbuilding issued quarterly by Lloyds. These are given in detail, in both table and chart form. On the subject of production per worker, the Memorandum reprints data from the report of the United States Bureau of Mines on the daily and annual coal production per man employed underground in numerous important coal-producing countries from 1901 to 1918. No data are submitted on variations in demand. Retail prices of food are shown by reproducing the material presented to the Brussels International Financial Conference by Professor A. L. Bowley.

Inadequate as this collection of material is, it is less unsatisfactory than the data brought together in Parts II and III on "causes," and "solutions." Among the causes cited are: the crisis in raw materials; the transport crisis; the shortage of plant; the exchange crisis; credit problems; numerous factors connected with labor; and psychological and moral factors. The solutions considered relate to: the democratization of industry; the question of piece-work rates; the specialization of labor; the improvement of apparatus; rates of exchange and raw materials. In general, the material on these subjects consists of statements taken from miscellaneous sources, with no attempt at evaluation or interpretation. No better characterization of the presentation can be given than the following quotation: "Whatever may be the qualifications of the author from whom we have borrowed these figures, we reproduce them here without expressing any personal judgment in regard to them."

The outline Plan of Enquiry and Questionnaires, constituting the second section of the Memorandum, is its least objectionable feature. True, the questionnaires are of such a nature as to solicit opinions rather than concrete data, and are in parts so general as to promise no satisfactory results. But the circulation of questionnaires in provisional form has its advantages. And the publication of this part of the Memorandum could be readily understood if its purpose were to secure for the Office the benefit of outside criticism.

There is no specific evidence, however, that any part of the Memorandum has been prepared with this end in view. Upon the whole, the report seems intended to prove the willingness of the Office to include in its Enquiry any item of information however remotely connected with production. There is a consistent indisposition to separate the significant from the irrelevant, the valuable from the worthless, the authoritative from the casual. The recurring promises of what the Enquiry *will* do are not to be taken seriously until there is more evidence of the Office's capacity for judicious discrimination.

Altogether, the Introductory Memorandum is an amazing document. It is a strange conglomeration of material—opinions, tables, and charts, good, bad, and indifferent. The body of the text is a mixture of plans which it is stated the enquiry will develop; of facts which are submitted in evidence in the study; and of inadequately supported statements drawn from every variety of source. The Memorandum as a whole is of a piece only in its extraordinary deficiencies—its careless composition, its superficial treatment of material, its unintelligent plan of procedure.

The events of the past year add a touch of irony to the entire issue. The crisis of underproduction has passed into a world-wide depression in which traders cannot dispose of goods on hand and manufacturers complain of accumulated stocks. An enquiry into production is needed as much as ever, but it should not be conducted along the lines nor in the spirit of the Labour Office's Introductory Memorandum. This ill-fated publication is an excellent example of what not to print. A fitting title would be: "Preliminary Office Notes—(Published by Mistake)."

Edmund E. Day

The Assessment of Physical Fitness. By Georges Dreyer, G.B.E., M.A., M.D. Cassell and Company, Limited: London, New York, Toronto, and Melbourne. 1920. 115 pp.

Dreyer commences his book with a statement that most of the existing tables dealing with the size of the normal human body are based on the theory that definite relations between age and height and weight exist. It has been satisfactorily proved that such relationships do not exist when individuals varying widely in size are examined. Dreyer's findings seem to indicate that definite relationships between weight of body and length of trunk (*i. e.*, the sitting height) and the circumference of the chest do exist, and that these have a definite relation to the vital capacity of the lungs.

He had previously determined these definite relations, not only between the weight and certain measurements of the body but also between these bodily measurements and the functional measurement of vital capacity, and presents his results with a hope that general application of these relationships might add greatly to our present knowledge regarding standards of health development, good physique, and physical fitness. After a careful examination of many thousand individuals, and an analysis of the results obtained, Dreyer is enabled to explain the relationship between weight and sitting height, weight and chest measurement, chest measurement and sitting height, vital capacity and weight, vital capacity and sitting height, and vital capacity and chest measurement, for both males and females, in the following formulae: *

Males

$$W = 0.38025\,\lambda^{\frac{1}{0.319}};\quad W = 0.662\,Ch.^{\frac{1}{0.365}};\quad Ch. = \frac{\lambda^{1.1442}}{2.00148};$$

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* W = weight of the body in grammes; λ = length of the trunk in centimetres; $Ch.$ = circumference of the chest in centimetres; $V.\ C.$ = Vital Capacity in cubic centimetres. The constants for Vital Capacity represent Class A.

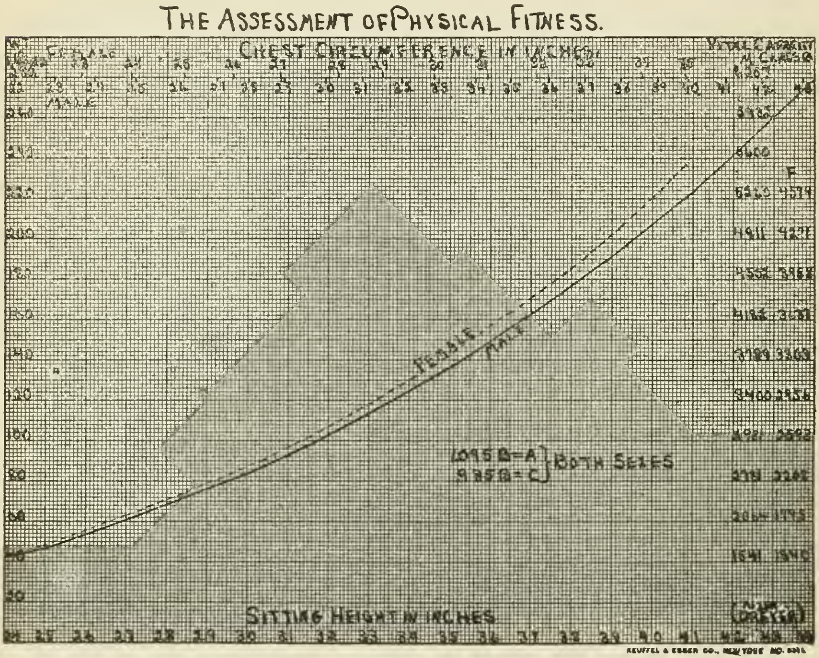
$$V.\,C.=\frac{W^{0.72}}{0.69};\quad V.\,C.=\frac{\lambda^{2.257}}{6.1172};\quad V.\,C.=\frac{Ch.^{1.973}}{1.5595}.$$

FEMALES

$$W=0.36093\times{}^{0.313}\sqrt{\lambda};\quad W=0.30213\times{}^{0.284}\sqrt{Ch.};\quad Ch.=\frac{\lambda^{0.9074}}{0.761833};$$

$$V.\,C.=\frac{W^{0.72}}{0.79348};\quad V.\,C.=\frac{\lambda^{2.3003}}{8.2714};\quad V.\,C.=\frac{Ch.^{2.5352}}{16.4951}.$$

The accompanying graph gives the substance of some ninety pages of tables which furnish information regarding the weight of the human body in its relationship to the sitting height, the chest circumference, and the vital capacity of the lungs. In this graph, English measures are used, except that vital capacity is expressed in cubic centimetres.



To make proper use of the graph, it is essential that all measurements should be taken uniformly, and as nearly as possible in the following manner:

WEIGHT. All weights should be taken as of the body without clothing.

LENGTH OF TRUNK. This should show the distance from the base of the spine to the top of the head. The subject's knees should be elevated sufficiently, the back should be straightened, and the eyes should look straight forward in such a manner that the exact length of vital stem may be obtained.

CIRCUMFERENCE OF CHEST. This should give as nearly as possible the measure taken by a tape in direct contact with the skin. In the males the tape should be held at the level of the fourth intercostal space in the nipple line. In the females this measure is taken at the same level, just under the breasts. At time of taking chest measurement there should be normal breathing.

VITAL CAPACITY. This is a measure of the maximum amount of air an individual is able to expel from the lung by voluntary effort, after taking the deepest possible inspiration. Record the best measure out of five trials. Dreyer finds the most suitable apparatus for this measurement to be made by Georges Boullite of Paris. It will be noted that there is a separate graph for males and for females. Such a division is essential because the two sexes differ in the particular measurements taken.

The tables are intended to be used for the following purposes:

1. The determination of what are the normal proportions between the weight, the trunk-length, and the circumference of the chest.
2. To gain evidence as to underfeeding or malnutrition during different stages of adolescent or adult life, as well as in various classes and occupations of the population.
3. For the study of the different aspects of physical fitness as measured by vital capacity in its relation to weight, trunk-length, and chest-circumference; for the comparison of adolescents with adults, and of the male sex with the female; for the comparison of different trades, occupations, and classes one with another, referring all to a definite common standard.
4. The application of these various measurements to patients with organic disease—*e. g.*, pulmonary tuberculosis—as well as to persons with functional disorders—*e. g.*, industrial fatigue, the fatigue of aviators, and so on.

To gain information concerning these various points, it is obvious that the tables must be used in the correct manner. To ensure this, a detailed description of their use, application, and limitations is now given.

To determine whether the weight of an individual is normal, it is necessary to take his sitting height and then to look up the weight corresponding to that height in the graph, or, in case Dreyer's work is available, in his tables. After taking the circumference of the chest, look up in the graph, or tables, the corresponding weight for that chest measurement. An average of these two weights should give within 5 per cent of the individual's true weight, providing he has a normal weight. For example, if the man's sitting height is 34 inches, he should weigh 125 pounds. If his chest circumference is 32½ inches he should weigh 127 pounds. The average of these two weights, 126 pounds, represents what he should weigh normally. A variation of

Less than 5 per cent indicates normal weight;
More than 5 per cent indicates possibly abnormal weight;
More than 10 per cent indicates probably abnormal weight;
More than 15 per cent indicates certainly abnormal weight in whatever direction the variation may be.

If the examinee has a normal weight in relation to his sitting height, but an abnormal weight in relation to his chest circumference, this condition indicates that his chest is either too large or too small in proportion to sitting height and weight.

For vital capacity, three readings are given under classes A, B, and C. The readings for Class B only are given in the accompanying graph. Class A includes trained army and navy men, policemen, athletes and active sportsmen, university students and boys in public schools engaged in playing games, members of the fire brigade, blacksmiths and boiler makers. The vital capacity of this class can be computed by multiplying the Class B readings by 1.095.

Class B includes professional classes, business men, railway men, high grade mechanics, the better class of school children, and clerks of the upper class.

Class C includes tailors, shop keepers, shoemakers, printers, potters, lower class clerks, painters, elementary school children, and factory children. The expected vital capacity for this class can be found by multiplying the Class B readings by 0.935.

If a person is found to have as much as 10 per cent less vital capacity than that indicated in the graph or in Dreyer's tables, it is possible that he is suffering from some health-depressing condition. If his vital capacity is as much as 15 per cent below that indicated in the graph, it is practically certain that he is subnormal in this condition. The method of determining what the vital capacity of an individual should be is exactly the same as that for finding what his normal weight should be. Quoting from the author again:

> "It is perhaps worth recording that changes in the vital capacity appear to offer an unusually trustworthy index of any improvement or deterioration taking place in the pulmonary lesions of patients with tuberculosis of the lungs. It also appears from the study of a tolerably large number of such cases that determinations of the vital capacity and its changes may be of value in prognosis, and help the physician to decide, for example, which patients are likely to benefit by further sanatorium treatment and which are not."

The author appears in this work to have supplied physical examiners with a method easily applied whereby physical fitness can be assessed on the basis of four very simple physical measurements, namely, that of sitting height, chest measurements, weight, and capacity of lungs.

FRANK M. PHILLIPS

George Washington University

Defects Found in Drafted Men. By A. G. Love and C. B. Davenport. Surgeon General's Office. New ed. Washington: Government Printing Office. 1920. 1559 pp.

The statistical reports of the results of examinations of American youths (ages 21 to 31) subject to the selective service, which were given out at the time of the examinations, were very instructive and enlightening. The present comprehensive volume deepens and strengthens the impression made by these reports, namely, that we had been negligent about cultivating and conserving the health and strength of our boys; it may also give more accurate statements, and it unquestionably adds materially to the information supplied. Much of this additional information is perhaps of little actual value, exhibiting slight chance variations between different sections of the country; but part of it is indeed illuminating.

The data embraced about 500,000 men rejected for the service, for health reasons, and about 2,000,000 men examined at mobilization camps. These constitute about four-fifths of all those examined; and, as the introduction puts it, they are "representative of all."

The general showing is an average of 468 persons per 1,000 examined defective in some way; on the average, these 468 show 557 defects, many persons being defective in two or more particulars. No less than 208 per 1,000 had some defect of the "bones, joints and the appendages of the hands and feet"; of these, 124 had weak feet and 50 had deformed or injured "appendages." Hernia was found in 40 out of each 1,000 cases; in 5½, spinal curvature.

The number of defects was found to be largest in Rhode Island, where the average was 802 per 1,000 persons; Vermont was second, with 764 per 1,000; the lowest number of defects per 1,000 persons was in Kansas, namely, 422.

Rhode Island was highest also in the number of defective men per 1,000 examined, namely, 640; but only 424 of these on the average were so defective as to cause rejection. This, however, was the largest number rejected per 1,000.

The lowest number of defective men per 1,000 was found in Kansas, namely, 354. Two states, however, had fewer men rejected than Kansas: Wyoming had an average of 128 rejected out of each 1,000 examined, and Nebraska, an average of 134; while in Kansas 147 per 1,000 were rejected.

Of the cities, Denver led in the number of defects, having 800 per 1,000 examined; but the compiler, no doubt justly, ascribes this "to selective gathering there of persons affected with active or latent tuberculosis." The cities in general, however, showed a much higher average than the rural districts, viz., 609 defects per 1,000 examined as compared with 528 in the rural districts.

The states (other than Rhode Island) with more than 500 defective men per 1,000 examined (viz., from 516 to 640) were Oregon, Washington, California, Colorado, Florida, Virginia, Vermont, Massachusetts, and Maine. The states with fewer than 425 (viz., 355 to 425) were Arizona, Texas, Arkansas, Kansas, Nebraska, South Dakota, Minnesota, Iowa, Indiana, Ohio, Kentucky, and South Carolina. It is noteworthy that there was no uniformity of figures in the north, south, east, or west; all four sections were represented in each class.

The view that Denver's very high ratio of defects is due to the incurrence of many tuberculous youths from other sections is upheld by the percentages of rejections for tuberculosis, which are highest in the states resorted to by tuberculous persons. The percentages are as follows:

PER 1,000 EXAMINED

Arizona	64	Colorado	49
New Mexico	61	California	43

States similarly situated but not used as resorts are among the lowest on the list, all having a record of 15 or under:

PER 1,000 EXAMINED

Wyoming	10	Utah	13
Montana	11	Idaho	14
Nebraska	11	Iowa	15
North Dakota	11	West Virginia	15
Delaware	13	South Dakota	15

With regard to venereal diseases, the largest rates are entirely in states in which the proportion of blacks to whites is greatest:

OVER 50 PER 1,000 EXAMINED	
Florida	163
Georgia	136
Mississippi	132
South Carolina	131
Louisiana	121
Alabama	115
Texas	112
Arkansas	105
Oklahoma	85
District of Columbia	81
Delaware	77
Virginia	71
North Carolina	70
New Mexico	67
Maryland	67
Missouri	65
Tennessee	65
Illinois	53
West Virginia	53

UNDER 25 PER 1,000 EXAMINED	
Vermont	13
South Dakota	16
New Hampshire	18
North Dakota	19
Utah	19
Wisconsin	20
Alaska	21
Oregon	22
Idaho	22
Wyoming	23
Massachusetts	24
Maine	24
Minnesota	24
Colorado	25

The record with regard to cases of syphilis per 1,000 examined is much the same:

OVER 10 PER 1,000 EXAMINED	
Alabama	38
Louisiana	33
Georgia	29
Delaware	24
District of Columbia	23
Oklahoma	23
Florida	22
Mississippi	22
Arkansas	20
Maryland	17
Missouri	17
South Carolina	16
North Carolina	16
Illinois	14
Indiana	10
Tennessee	10

UNDER 5 PER 1,000 EXAMINED	
Idaho	1
Vermont	2
Oregon	2
Wisconsin	3
New Hampshire	3
South Dakota	3
Maine	3
North Dakota	3
Utah	3
Massachusetts	4
Colorado	4
Washington	4
Rhode Island	4
New Jersey	5
Alaska	5
Connecticut	5
New York	5

In both tables the figures are the nearest whole numbers to the numbers given in the report; where the numbers given equal the limiting number, they represent fractional numbers lower than the limit by less than one-half.

In the public press it was reported not long ago that Utah had the lowest percentage of venereal diseases and of syphilis. This proves not to be the case. Vermont has the lowest percentage of venereal diseases, with a record of 13 per 1,000 examined, while Utah is fifth lowest, with a record of 19 per 1,000; with regard to syphilis, Idaho leads, with a record of but 1 per 1,000; while Utah is ninth, with a record of 3 per 1,000.

For the whole country the average of tuberculous persons was 30 per 1,000 examined; of those with venereal diseases, 32 per 1,000. Tuberculosis was less common among country boys, taking the average throughout the country.

For the whole country, the number per 1,000 examined found to be afflicted with venereal disease was not materially lower for the country than for the cities. Another interesting statement is that in the whole country 1,488 cases of drug addiction were found, as against only 853 of alcoholism.

With regard to mental deficiency, the highest ratios, running from 16 to 31 per 1,000 examined, were found in states in which some part of the population has been shut off, largely interbreeding; these are Louisiana, Mississippi, South Carolina, North Carolina, Virginia, Vermont, Maine.

The analysis of the experience in New York state by sections shows:

With regard to tuberculosis, the highest is in the Adirondack region, a resort for consumptives; the lowest is in the suburbs of New York City.

With regard to venereal diseases, the highest is in the "western manufacturing section," including Buffalo; the lowest is again in the suburbs of New York City, with the city itself a close second.

With regard to mental defects, the highest is in the Catskill section, with its old, long-settled, intermarrying regions, while the very lowest is in New York City. The Catskill section has also the highest percentage of epilepsy.

Miles M. Dawson

The Problem of Estimation. By Correa Moylan Walsh. London: P. S. King & Son. 144 pp.

This little monograph, by the author of *The Measurement of General Exchange Value*, will be welcomed by all students of index numbers. It will doubtless be read by many such who have not been willing to devote the greater time required for reading the author's earlier and larger book. The present volume does in fact include the gist of the larger work besides adding the author's later and maturer conclusions. The earlier book, *The Measurement of General Exchange Value*, is the most elaborate and scholarly book on index numbers that has yet appeared and it has therefore become a classic in the literature of that subject; although, because of its minute and technical character, it has inevitably had very few readers.

Having read and reread both books I am filled with admiration for the author's keenness and for his painstaking industry. He has covered very thoroughly the antecedent literature and has worked out the details and the peculiarities of many formulae and methods. Inasmuch as the author does not consider himself a mathematician, his thoroughness and penetration in what is, after all, a mathematical field, seem remarkable.

If I were to offer any adverse criticism it would be chiefly that the method of the writer seeks too much to lead the reader from the consideration of special cases up to general cases, instead of the reverse. In some instances, at least, he could have made it easier for the reader, if not for himself, had he proceeded in the opposite direction. As J. Willard Gibbs, the mathematical physicist used to say, "the whole is simpler than its parts."

It should be stated that *The Problem of Estimation* is more than a treatise on index numbers. The subject of index numbers proper occupies only the last fifty pages. The other ninety pages will be of less interest to the economist, although they help materially to introduce the author's presentation of the theme of index numbers.

The book consists of an Introduction in which "the controversy" is formulated, a second part on "Averages and Errors," and a third part on "Deviations and Variations."

The "controversy" is presented rather entertainingly by propounding an old problem treated by Galileo and others of his time: "If a horse worth one hundred crowns is estimated by one person at one thousand and by another at ten, which of these two estimates is the less erroneous, or are they equally erroneous?" Galileo maintains that the two guesses are equally erroneous, while a certain Nozzolini stoutly argues that 10 is nearer the mark (100) than is 1,000. This leads naturally to a discussion of the arithmetic and geometric means. Geometrically, ten and one thousand are equally distant from one hundred, one being ten times as much and the other ten times as little, whereas, arithmetically, ten is nearer one hundred than one thousand, being only distant by a difference of ninety as compared with the other difference of nine hundred.

As in his former work, the author devotes most of his effort to contrasting the advantages and disadvantages, for various purposes, of the geometric, arithmetic, and harmonic means. He offers various criticisms—not always very important—of other writers on index numbers, including Edgeworth, Bowley, and myself.

One of the parts of the book which most interested me, personally, is that concerning the formula on page 102. This is the formula which I have offered in the March number of the QUARTERLY PUBLICATIONS as the best formula for an index number. Walsh, from an entirely different approach, has reached the same conclusion. The particular merit of this formula, which he seems to regard as the most important, is quite apart from the merits which I have brought forward. It is that this formula comes nearest to fulfilling "Westergaard's test." No formula has been found which completely satisfied Westergaard's test (except formulae with obviously improper weighting). This so-called test of a good index number is that, by its use, a comparison between two years *directly*, such as 1913 and 1921, ought to correspond to the result obtained *indirectly*, by putting together a chain of index numbers for intervening years. Although the formula which he and I agree is the best does not perfectly fulfil Westergaard's test, he thinks it comes nearer to it than any rival formula.

It was evidently the hope of finding the formula that would fulfil Westergaard's test which has twice called Walsh into this field of research. He is disappointed not to have found the object of his search, and expresses a suspicion that perhaps the problem, like squaring the circle, is after all insoluble.

As I stated in my March paper, I hope to show later that this suspicion is well grounded and, furthermore, that Westergaard's test is not a true test at all, but presents an ideal which is not only unattainable but false.

But just as the search for a method of squaring the circle or discovering "the north-west passage" were by no means fruitless, so Walsh's research has reached many results of value to science, especially to the science of Index Numbers.

IRVING FISHER

Rules for Reporting Information on Railroad Employees, together with a Classification and Index of Steam Railroad Occupations. Reporting forms and classification plan, prepared by the United States Railroad Labor Board, and approved by the Interstate Commerce Commission, to be used by carriers in reporting wage and compensation data to the United States Railroad Labor Board and to the Interstate Commerce Commission. (To be effective July 1, 1921, superseding Order June 17, 1915, and supplementary Order July 13, 1917.) May, 1921. 320 pp.

The introductory statement to the report gives at the outset the following brief description of its seven main divisions:

1. Statement on the present reporting plan, and the purposes, character and uses of the revised occupational classification of railroad positions
2. Rules governing the classification of steam railway employees and reports of their service and compensation
3. Reporting forms to be used by steam railroads in reporting information on railroad employees to the Interstate Commerce Commission and to the United States Railroad Labor Board
4. Detail on Reporting Divisions contained in the forms for reporting wage and other information by steam railroads to the Interstate Commerce Commission and to the United States Railroad Labor Board
5. Outline of the occupational classification of railroad positions
6. Occupational classification of railroad positions
7. Alphabetical finding list of illustrative payroll and distinctive class titles of railroad positions

Typical of the common experience with occupational classifications is the history of the federal classification of railway positions. The early classification was a simple affair with 18 occupational groupings. On July 1, 1915, a revised classification was adopted providing for the separation of occupations into 68 groups, and it has served as the basis for the statistics since published by the Interstate Commerce Commission on service and compensation. When the attempt was made to use this classification for the solution of concrete problems of personnel administration and control it was found too general. The report says:

> "During the period of federal control the United States Railroad Administration found it difficult in the adjustment of wage and other disputes to secure the type of statistical information as to service and compensation of railroad employees which it required. The Railroad Wage Commission in circulating questionnaires as a basis for the first award—General Order No. 27—used primarily the sixty-eight (68) groupings of occupations in effect at the time.
>
> The Board of Railroad Wages and Working Conditions, appointed by the Railroad Administration, experienced the same difficulty that was encountered by the Railroad Wage Commission in using the data on wages compiled in accordance with the groupings prescribed by the Interstate Commerce Commission. Accordingly, in special cases, elaborate questionnaires were circulated to secure the desired information. Due to the difficulty experienced by it, the Railroad Administration submitted to the Interstate Commerce Commission for its approval a proposed classification of railroad occupations embodying one hundred and twenty-five (125) distinctive groupings of occupations and with it report forms for reporting both service and compensation according to these distinctive groups. These report forms provided not only for expanding the occupational groupings from 68 to 125, but also provided that employees' services should be separated as between overtime, straight time, special allowances, etc. It also provided that compensation should be similarly distributed.
>
> Meanwhile, under the Transportation Act, 1920, the United States Railroad Labor Board was created. This Board inherited a great number of requests for the adjustment of disputes between employers and employees and such an adjustment was provided by the Board in Decision No. 2. In deciding the questions at issue, however, the Board was seriously handicapped because of the absence of wage data relating to homogeneous groups of occupations and classified according to the special working conditions found in railway operation. The absence of data was in part

> compensated for by the mass of information which was inherited from the Board of Railroad Wages and Working Conditions and without which it would have been difficult, if not impossible, properly to review the claims of the contending parties. Provisions for the current collection of similar data, however, had not been made and it seemed evident that steps would have to be taken by the United States Railroad Labor Board to secure such current and properly classified data if it were correctly to perform its functions according to the provisions of the law."

Before the classification with 125 groupings as proposed by the Railroad Administration had been officially adopted by the Interstate Commerce Commission, the Railroad Labor Board was created, and it requested the Commission to defer approval of this classification until the Board had had time to study the subject in relation to its particular problems and purposes.

The new classification is the result of this study. It recognizes 500 distinctive classes of positions, in addition to the positions in "the Executive, Official, and Staff Assistant Service." "These classes are the smallest units provided for in the classification and are made up of positions carrying essentially similar duties and responsibilities. Each class is given a distinctive title and described so far as is necessary to indicate the kinds of positions which fall under such distinctive class." For purposes of reporting statistics the 500 "classes" and the executive, official, and staff assistants are grouped into 148 divisions, most of the divisions containing a number of fairly homogeneous "classes."

In spite of the 500 classes and an almost inevitable demand for simplicity, one may hazard the prediction that the tendency will be toward an increase in the number of classes rather than toward a decrease. There is no royal road to simplicity. The degree of diversity of the occupations in the industry must determine the number of classes if the classification is to be a useful, practical instrument for improving the conditions of employment and the relationship between employer and employee.

The Railroad Labor Board and the Interstate Commerce Commission are to be congratulated on their decision to go to the fundamental unit, the class of positions with like duties and responsibilities, in the presentation of the classification rather than to give only the divisions into which these classes are to be grouped for the purposes of reporting statistics. The section on the purpose of the classification begins with the statement:

> "The purpose of the occupational classification of railroad positions is to furnish a basis for the collection of wage and other data on homogeneous classes of railroad positions, to establish as nearly as can be a uniform terminology to be used in describing similar occupations, and to describe classes of positions so that all railroads may have the same general understanding of the kinds of positions that are to be included in any class."

The introductory statement concludes with the illuminating sentence:

> "It is hoped, however, that the classification in its detailed form will prove of such value to the railroads in viewing their employment problems as a whole that they will, of their own free will, install it as a basis for employment administration, and reap the advantages which would accrue therefrom."

In other words, it is another classification that has been broadly conceived and broadly executed.

Against detailed specific classifications an argument is now being advanced in some quarters that it tends to establish jurisdictional lines for occupations, that employees in one class will object to performing certain duties, even temporarily, because those duties are not enumerated in the description of their class and are enumerated in the description of some other class. The report is specific in its statement that the classification is not to be so construed. It says:

> "The occupational classification is in no way and under no circumstances to be interpreted by the Board, by the Interstate Commerce Commission, by the railroads or by other interested parties, as setting up jurisdictional lines for occupations, or as limiting the kinds of work which employees may perform or the duties which they may assume. In preparing the occupational classification, the Board has not aimed to standardize for the railroads the occupational duties assigned to, or the kinds of work performed by their employees, and nothing in the classification nor in the report forms is to be construed in this light."

The admission must be frankly made that a detailed classification probably does tend to bring controversies to an issue. Under a broad general classification facts may be buried or disguised, whereas a detailed classification brings them to light, and it may do so at an embarrassing time. Such situations must, however, be faced and controversies settled; and the more promptly and courageously this is done the better it will be for all concerned. The trouble in the past has been to get the facts. The progress in this direction promised by the new classification and the rules will more than offset any disadvantages that may accrue through any jurisdictional disputes that may arise.

Of the classification proper the report says:

> "The basis and general plan of the occupational classification conform to the recognized lines and the best practice which have been followed by industrial and governmental organizations in the development of employment classifications for their services, the entire plan being based upon the principle that duties and responsibilities must control in any orderly arrangement and classification of positions."

To this statement one can readily subscribe, for the work of classification of employments has progressed to the point where there are in broad general matters recognized lines and a best practice, and with these standards the classification seems in general to be in harmony. One misses under the statement of duties and responsibilities any description of the qualifications required for filling the positions, but of course no such statement is necessary for the primary purpose for which the classification is developed. Recruitment and promotion are processes in employment with which the railroads and not the Commission or the Board are primarily concerned. Doubtless railroads which use the classification for personnel administration will find it helpful, in formulating their standardized employment policy, to supplement the classification by adding statements of what they require for entrance into the several classes of positions. In the public service such statements are of more immediate importance than in industrial establishments, but as the truth is learned it will doubtless be that big private enterprises do not differ very radically from the government with respect to what is best in methods of recruiting.

In providing for reports to the Commission and to the Board two forms are to be used, Form B relating to the train and engine service, and Form A to all other employees. Form A requires monthly for each of the 130 reporting divisions of occupations a statement of (1) number of employees in the middle of the month; (2) number of full time positions (average for the month); (3) service hours (or days) of (a) straight time actually worked, (b) overtime paid for at pro rata rates, (c) overtime paid for at punitive rates, (d) time paid for but not worked, and (e) total time paid for; and (4) compensation for (a) straight time paid for, (b) overtime paid for at pro rata rates, (c) overtime paid for at punitive rates, (d) time paid for but not worked, and (e) total. Form B for the train and engine service calls for the number of employees not only at the middle of the month but also on the 7th, the 22nd, and the 28th, and it omits the number of positions. It calls, broadly speaking, for similar information regarding service hours and compensation, and then asks for miles actually run and miles paid for but not run, and for the total number of trips for which not less than a minimum day was paid.

The report leaves one with the impression that now the country is to get the facts regarding railroad employees and railroad labor.

Lewis Meriam

Negro Migration during the War. By Emmett J. Scott. New York: Oxford University Press. 1920. viii, 189 pp. (Carnegie Endowment for International Peace, Preliminary Studies of the War, no. 16.)

Some one, doubtless, in days ahead, will find it worth while to write an account of mobility of labor, geographical and occupational, during the war. Though he will perhaps trace no more extraordinary instance of international migration than the shipment of many thousands of coolies from Asia across Canada and the United States to Europe, he will hardly discover a more impressive case of internal migration than that of the negroes who moved northward in the United States. How many had a part in this movement cannot be said with precision; estimates and vague guesses added together give over 400,000. Their going had all the characteristics of a mass phenomenon, a herd movement, like all the great migrations of history. The rationality of the mass was put above individual calculation. "Drivers and teamsters left their wagons standing in the street. Workers, returning home, scrambled aboard the trains for the North without notifying their employers or their families." The economic bait was the most powerful in its attraction, but the notion of deliverance was also present. Part of this had a deep religious cast: "The movement was called the 'exodus' from its suggestive resemblance to the flight of the Israelites from Egypt, *The Promised Land, Crossing over Jordan* (the Ohio River), and *Beulah Land.*" In part the notion of deliverance was a specific reaction against the oppressive social and economic discriminations of the South. Just how important the latter factor was is made less clear in Mr. Scott's study—perhaps intentionally so—than we could wish.

The author tells us a good deal about the sources of the migration, its course, how (as by letters and labor agents) the attraction was given an opportunity to act, what efforts, lawful and unlawful, were made to check the emigration, how it fared in different parts of the North, what gains were realized, where disillusionment came, how public opinion viewed the whole procedure, and what national remedies might avail.

As a study of the causes and course of emigration, at least its psychological phases, the volume has permanent value. Reading it, one is led to wish that studies of this sort were available for the great European migrations; but none of broad scope exists, I believe, except for Italy and Sweden, both of which are governmental.

In the present book there is nothing noteworthy from a statistical point of view, and some portions are weak. The author, for instance, though realizing that the figures given for the dimensions of the recent movement are of uncertain value, is willing to reproduce uncritically precise figures for some earlier movements which can have rested on a no more certain basis. The bibliographical scholarship is crude: footnotes, for example, refer to periodicals by volume, not stating authorship, which also is not stated in the text, and the items of the appended bibliography of books and periodicals are arranged on no discernible principle. A volume issued by the Division of Economics and History of the Carnegie Endowment for International Peace ought to maintain a higher standard in this respect.

Robert F. Foerster

Methods and Results of Testing School Children. By Evelyn Dewey, Emily Child, and Beardsley Ruml. E. P. Dutton and Company: New York. 1920. 170 pp.

Before me are two published estimates of this book. Judging by these two comments only, one might infer that the book reviewed here is concerned with some such temperamental topic as relativity or the like. One estimate is given by Fowler D. Brooks, of Johns Hopkins University, and is taken from his doctor's dissertation:

> "Dewey, Child, and Ruml have carried out one of the most scientific experimental studies in educational psychology."

The other estimate is by Walter S. Monroe, of the University of Illinois, and is quoted from the *Journal of Educational Research.* Among other somewhat more complimentary remarks, he says:

> "This book does not appear to be of major importance. The average school man will find little in it that is helpful."

Both estimates are correct. From the point of view of the advanced student of technical mental measurement and mental statistics, the book is a model. It is in fact probable that the statistical refinements exceed the refinements in the original data. Although there are no original contributions in the way of techniques, with perhaps two minor exceptions, the whole investigation was conceived and executed in accordance with the highest traditions of psychological and statistical methodology. I read the book before I was invited to review it, and immediately placed it upon the list of reference readings for my students of mental measurement and statistics. But to the average school man the significant portions of the book are relatively valueless, primarly because they are incomprehensible. Final evaluation as to immediate utility of the investigation should be postponed, however, until a promised second volume has appeared. It is probable that this second volume will deal with more practical and popular matters.

The investigation undertaken by Dewey, Child, Ruml and others had several objects. One aim was to select or construct a series of mental tests which would give as complete a picture of a child's mental processes as possible. Very wisely, I believe, the investigators made no attempt to isolate and measure the various interwoven mental traits. As far as possible they tried to rid themselves of any hypothesis concerning the nature and constitution of mental ability. They selected and, in several instances, originated mental tests which measure various practical activity-wholes. Finally, they so standardized the method of applying and scoring each test as to make it quite objective and, in particular, quantitative. A few mental diagnosticians still base their diagnosis upon highly subjective and relatively inexplicable interpretations of a child's subtle behavior hints while taking a test. These investigators, on the other hand, wished not only to base their diagnosis upon objectively and quantitatively scored reactions—to diagnose "by" tests not "from" them—but also to secure a body of data susceptible to statistical manipulation.

A second aim of the investigation was the establishment of age norms for a homogeneous group. They employed an ingenious and, in part, original method for selecting public school pupils so as to secure a representative sampling for each desired age of East Side Jewish children in New York City. The various mental tests were given to one pupil at a time. The mean score for each test for each age became the norm of that age. Equations are presented whereby a norm may be computed for any intervening age.

A third aim was to select, from plans previously originated, a method for reporting a child's score so that it would be interpretable immediately and would be comparable from test to test. Both purposes were achieved by expressing each child's score as a sigma deviation from the norm for his own age for the test in question. It should be noted that this plan makes no provision for making more accurate the original units of measurement, namely, crude score units, nor does it permit a direct comparison between scores made by pupils of one age group and scores made by pupils of another age group. The former is a defect, while the latter is only an inadequacy.

A fourth aim was the preparation of a maturity scale, or, more exactly, a maturity test, since no attempt was made to scale the tests employed. By means of the partial-correlation-and-regression-equation technique those tests were chosen for the maturity scale which had the largest independent diagnostic significance. The criterion employed for determining the independent diagnostic significance of each test was chronological age. This use of chronological age as a sole criterion is something of a surprise in view of the fact that most mental measurers, when preparing an omnibus intelligence test, customarily employ chronological age as only one of several criteria and usually prefer such criteria as: the age of reaching a given school grade; a composite of the several tests used; school marks; estimates of teachers; previously established intelligence tests, etc.; or a weighted composite of one or more of these. The use of chronological age alone as a criterion might give as much influence to body weight in determining a child's intelligence as to skill in reasoning. The authors foresaw that the validity of their criterion would be attacked. They anticipated such attacks by naming their scale a *maturity* scale, rather than an *intelligence* scale, and by pointing out the consequent limitations. It is significant, however, that one competent reviewer failed to perceive this distinction and wrote as though the maturity scale were an intelligence scale. In my judgment the maturity scale will prove a reasonably satisfactory intelligence scale because the investigators were discriminating workers. Before applying their criterion they partially parried criticism by eliminating those tests which were primarily physical rather than mental. Suffice it to say that chronological age is a satisfactory criterion for maturity tests but not for intelligence tests unless employed with discrimination and unless supplemented by subordinate criteria—more subordinate criteria, in fact, than were employed by Dewey, Child, and Ruml.

A fifth aim was to correlate scores made on the various mental tests with the home environments of the children. This aim failed of realization because of the unusual homogeneity of environments. Generalizations from the social data secured are given, however, in order that future investigators may have fuller knowledge of the children upon whom the test norms were based.

A sixth aim was to correlate the physical records for the children with their mental records. For various reasons an ambitious program of physical measurements was reduced, finally, to measurements of weight, height, head, chest, teeth, and blood pressure. Age norms for these and for certain resulting ratios are presented. But the really best result from this portion of the investigation is summarized in this quotation:

> "The great need of the development of a standardized procedure and terminology for the use of medical examiners in making such mass studies of normal children was very apparent from the analysis of our material."

This is the second investigation of mental and physical relationship I have seen substantially fail because of a belief on the part of non-medical individuals that medical science has devised a system of exact, objective, and quantitative measurement of significant physical conditions. One such investigation I recall very vividly because I myself was the victim of such a misapprehension.

In summary, and in the words of the authors:

> "This volume furnishes a guide for workers who may wish to use the methods employed here for clinical work or for further investigation. The tests with their instructions and norms, the maturity scale with an explanation of its meaning and use, and a summary of the social and physical studies are presented. A further publication will deal with the possibilities of interpreting the objective data of mental tests. An analysis will be made of relationships found for the physical, school, and test measures, from the point of view of the practical problems presented by school children."

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QUARTERLY PUBLICATION OF THE

AMERICAN STATISTICAL ASSOCIATION

A SPECIAL APPLICATION OF PARTIAL CORRELATION*

By W. L. Crum, *Williamstown, Massachusetts*

It is well known that if two ordered statistical series—for instance, two historical economic series—are subject to rectilinear trends, their correlation coefficient is influenced by that fact. Since it is ordinarily desired to determine the degree of correlation which is independent of the normal trends, it becomes necessary to separate in each series the variation due to trend from the miscellaneous variation. A common method† of accomplishing this consists in determining the line of trend and correcting the items of the given series by corresponding amounts. In other words, the plan is to study the deviations of the items from the line of trend rather than the horizontal. The object of this paper is to interpret this process in terms of the partial correlation coefficient and to call attention to a corresponding direct method of eliminating the secular trend.

I. STANDARD DEVIATION

Suppose that a single series of N items, x_i, is ordered relative to a particular variable which, although it need not be the time, will be represented by t; and assume that the series has a trend which is substantially rectilinear. It is sought to find this line of trend and to determine the standard deviation of the x_i relative to it. From among the methods of locating the line, we adopt that of least squares.

Let the equation of the line be

$$x=bt+a$$

and let ξ_i be the residual obtained by diminishing x_i by the above value of the ordinate x for t equal to t_i. Then the function which is to be made minimum is

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* Read before the American Mathematical Society on September 9, 1921, under the title "The significance of the partial correlation coefficient in the comparison of ordered statistical series possessing rectilinear trends."

† Persons, Warren M., "An Index of General Business Conditions," in particular Part II ("Method used"), in *Review of Economic Statistics*, April, 1919.

$$\begin{aligned}\Sigma\xi^2_i &= \Sigma(x_i - bt_i - a)^2 \\ &= \Sigma(x_i - a)^2 - 2b\Sigma t_i(x_i - a) + b^2\Sigma t^2_i\end{aligned}$$

and the conditions furnishing a minimum are

$$a = X - bT, \text{ where } X = \frac{1}{N}\Sigma x_i, \text{ and } T = \frac{1}{N}\Sigma t_i \qquad (1)$$

together with:

$$b = \frac{\Sigma t_i(x_i - a)}{\Sigma t^2_i}. \qquad (2)$$

The first of these conditions expresses the fact that the line passes through the point having as coördinates the arithmetic means of the t_i and x_i, and the second gives the slope of the line of best fit.

The corresponding minimum value of the function is

$$\Sigma\xi^2{}_i = \Sigma(x_i - a)^2 - b^2\Sigma t^2_i = \Sigma(x_i - X)^2 - b^2(\Sigma t^2_i - NT^2)$$

giving

$$\sigma^2{}_\xi = \sigma^2{}_{x.t} = \sigma^2{}_x - b^2\sigma^2{}_t \qquad (3)$$

where σ_x is the ordinary standard deviation of the x_i, and σ_ξ is the standard deviation of the residuals. In other words, σ_x is the standard deviation of order zero, and σ_ξ— or, $\sigma_{x.t}$— is that of the first order.*

It is evident that $b^2\sigma^2{}_t$ can never exceed $\sigma^2{}_x$, and can equal it only in case the original distribution is precisely rectilinear; and, moreover, $b^2\sigma^2{}_t$ can never be negative, and is zero only if the trend is horizontal. Hence, $\sigma_{x.t}$ is zero only if the actual distribution is exactly rectilinear, and has its maximum value of σ_x only in case the trend is horizontal.

It is suggested that for certain purposes the coefficient $\sigma_{x.t}$ is a better measure of fluctuation than σ_x. Whereas σ_x is ordinarily used to measure dispersion, $\sigma_{x.t}$ indicates the degree of divergence of the items from the line of normal trend. The difference between the squares of the two, $b^2\sigma^2{}_t$, is the square of the standard deviation of the ordinates of the line of trend. In calculating $\sigma_{x.t}$ no correction for trend need actually be made in the given items: the value is obtained directly by use of equation (3), and the work is particularly easy if the t_i are successive integers.

Since the coefficient of correlation† between x and t is defined by

$$r_{xt} = b\frac{\sigma_t}{\sigma_x} \qquad (4)$$

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* Yule, G. U., *An Introduction to the Theory of Statistics*, chap. xii, sec. 6; 5th ed., London; Charles Griffin & Co. 1919.

† *Ibid.*, chap. ix, sec. 10.

equation (3) may be written in the form *

$$\sigma^2_{x.t}=\sigma^2_x(1-r^2_{xt}). \tag{5}$$

II. CORRELATION

We address ourselves next to the examination of the correlation between one ordered series, x_i, having rectilinear trend defined by the parameters a_x and b_x, and a second, y_i, with trend defined by a_y and b_y. Let it be supposed at the start that the correlation is not subject to any lag.

The equations of the two lines of trend are

$$x=b_xt+a_x,\ y=b_yt+a_y$$

and, if ξ_i and η_i are the residuals obtained by diminishing the ith items of the two series by the ith ordinates of the respective lines of trend,

$$\xi_i=x_i-b_xt_i-a_x,\ \eta_i=y_i-b_yt_i-a_y.$$

It was remarked at the beginning that the correlation sought is that which exists between these residuals, namely, $r_{\xi\eta}$. Its calculation involves the product sum Np, where

$$\begin{aligned}Np&=\Sigma\xi_i\eta_i\\&=\Sigma(x_i-b_xt_i-a_x)(y_i-b_yt_i-a_y)\\&=\Sigma(x_i-a_x)(y_i-a_y)-b_xb_y\Sigma t^2_i\\&=\Sigma(x_i-X)(y_i-Y)-b_xb_y(\Sigma t^2_i-NT^2)\\&=(r_{xy}-r_{xt}r_{yt})N\sigma_x\sigma_y\end{aligned}$$

by use of (1), (2), (4). Furthermore, using (4) and (5) with this result,

$$r_{\xi\eta}=\frac{r_{xy}-r_{xt}r_{yt}}{\sqrt{1-r^2_{xt}}\ \sqrt{1-r^2_{yt}}}=r_{xy.t}. \tag{6}$$

We find, therefore, as might have been foreseen, that the correlation between ξ_i and η_i, as ordinarily calculated by "correcting" the variates x_i and y_i, is merely the partial correlation† of x_i and y_i, independent of t. Thus, in calculating the correlation between ξ_i and η_i, we are relieved of the necessity of correcting for trend: the arithmetic involved in computing the residuals ξ_i and η_i is eliminated entirely. The simpler process is to use formula (6) directly: the coefficients r_{xt} and r_{yt} must be evaluated anyway in order to locate the lines of trend, and the labor of determining r_{xy} is no greater than that of finding $r_{\xi\eta}$.

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* *Ibid.*, chap. ix, sec. 14; and chap. xii, sec. 3.

† *Ibid.*, chap. xii, sec. 13.

It is to be noted that this method applies only for the elimination of rectilinear trends. If it is desired to correct also for so-called seasonal variation before examining correlation, the computation of the partial correlation coefficient will not automatically effect that correction; but even in this case it will eliminate the rectilinear factors.

III. EFFECT OF LAG

It remains to inquire into the influence of lag upon the conclusion of Section II. Suppose that y lags behind x by an amount L: that t'_i, the value of t associated with y_i, is L less than t_i, the value of t associated with x_i. The residuals are, on this assumption,

$$\xi_i = x_i - b_x t_i - a_x, \quad \eta_i = y_i - b_y t'_i - a_y$$

and the product sum takes the form:

$$\begin{aligned} Np = \Sigma \xi_i \eta_i &= \Sigma (x_i - b_x t_i - a_x)(y_i - b_y t'_i - a_y) \\ &= \Sigma (x_i - a_x)(y_i - a_y) - b_x b_y \Sigma t_i t'_i \\ &= \Sigma (x_i - X)(y_i - Y) - b_x b_y (\Sigma t_i t'_i - NTT') \\ &= \Sigma (x_i - X)(y_i - Y) - b_x b_y \Sigma (t_i - T)(t'_i - T') \\ &= (r_{xy} - r_{xt} r_{yt'} r_{tt'}) N \sigma_x \sigma_y \end{aligned}$$

giving

$$r_{\xi\eta} = \frac{r_{xy} - r_{xt} r_{yt'} r_{tt'}}{\sqrt{1 - r^2_{xt}}\,\sqrt{1 - r^2_{yt'}}}. \tag{7}$$

It is evident that the value given by (7) is not exactly the partial correlation coefficient, but differs from it by the multiplier $r_{tt'}$ in the second term of the numerator. Nevertheless, the calculation of the lagging correlation between ξ_i and η_i is facilitated by the use of (7) rather than the laborious method of correcting the original items. As the t_i and t'_i differ ordinarily by a constant lag, r_{tt}' will generally be unity in the cases arising in practice. In fact, we have

$$t'_i = t_i - L$$

and, if the lag is constant, the arithmetic means T, T' will be related by

$$T' = T - L.$$

Hence quantities of the type $t'_i - T'$ reduce to $t_i - T$, and the numerator and denominator of r_{tt}' become identical: the coefficient of correlation between t and t' reduces to unity, as might have been foreseen, since the relation between the two t series is perfect when L is constant.

Therefore formula (6) and the conclusion of Section II still hold when there is lag, provided the lag is constant. This will cover all the simpler cases arising in practice. Should it be desirable, however, to compare two series with variable lag, formula (7) can be used; and the calculation of the coefficient r_{tt}' will not greatly complicate the work.

A PRICE INDEX OF OIL STOCKS

By Joseph E. Pogue, *New York*

For a number of years the writer has been conducting a continuing economic study of the petroleum industry, based partly upon the relatively ample statistics with which this field is favored and partly upon the technology involved in the production, refining, and utilization of petroleum.* In order to ascertain whether the course of petroleum shares on the stock market is influenced by economic conditions peculiar to petroleum or is wholly a function of the forces common to the movement of industrial shares in general, a price index of oil stocks has been prepared and will be maintained. A brief description of the method employed and the results attained is herewith presented.

The preparation of a practical stock index involves greater difficulties than many other types of indices, owing to the rapidity and the degree of scatter characteristic of the individual quotations, and the tendency of some of the items to die away and thus "load" the index with inactive components. The conventional type of index as calculated by financial journals and consisting merely of an arithmetic mean of a selected number of quotations is a crude expedient, as has been critically shown by Wesley C. Mitchell.† The main trouble with this type of index is that it is dominated by the more vigorous of its components and is, therefore, not a representative index.

Obviously, if the more vigorous and more costly stocks are not to dominate in an index, the items must be weighted. The weights may be assigned directly to the items or introduced indirectly by converting the quotations into percentages of a fixed base. The latter method was preferred because it affords a double comparison and lends itself to convenient treatment.

In the preparation of the oil index twenty petroleum stocks were selected: five Standard Oil shares; 5 shares of representative companies listed on the New York Stock Exchange; 5 shares of companies listed on the New York Curb; and 5 shares of companies operating primarily in foreign countries. A monthly average price was calculated by averaging the closing quotation on Friday of each week. The monthly averages so obtained were then converted into index numbers representing for each item the percentage of its average price in 1919.

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* The writer believes that a combination of statistics and technology opens up a very fertile field for research in industrial economics.

† "A Critique of Index Numbers of the Prices of Stocks." *Journ. Polit. Econ.*, July, 1916, pp. 625–93.

The next step was the calculation of a representative average of the twenty index numbers for each month. An arithmetic average offers the objection that the stocks which decline most rapidly in price have a decreasingly important effect upon the average. This difficulty is largely overcome by use of the geometric mean which accentuates the weight of the smaller index numbers. The median was also determined.

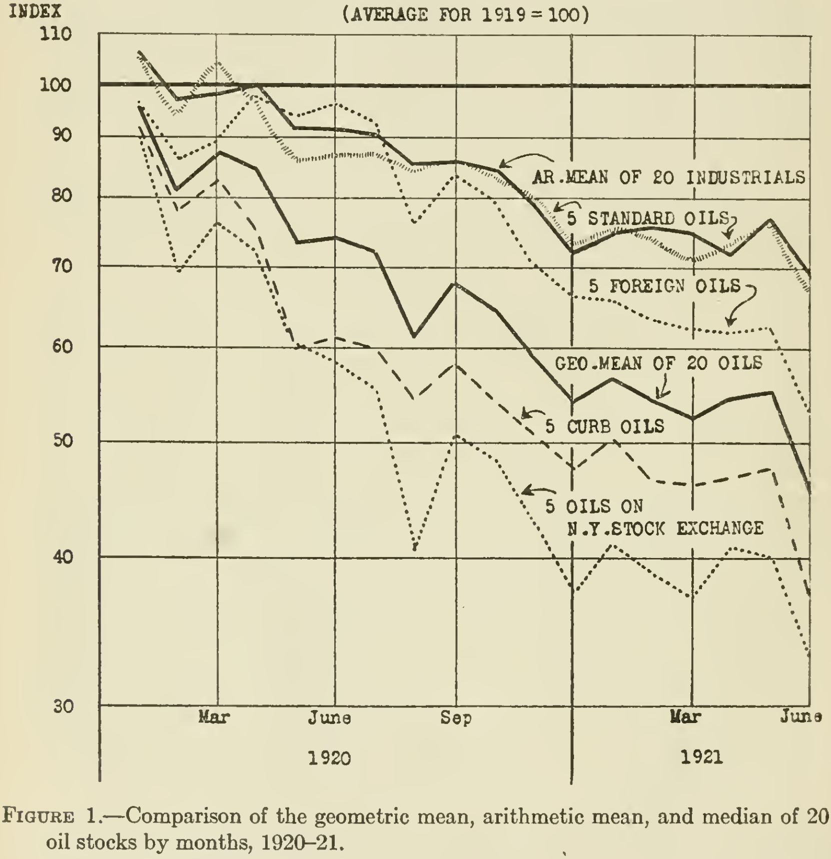

FIGURE 1.—Comparison of the geometric mean, arithmetic mean, and median of 20 oil stocks by months, 1920–21.

The three composites so obtained—geometric mean, arithmetic mean, and median—are given on a semi-logarithmic scale in Figure 1 by months for 1920–21. It will be observed that the three curves show closely concordant fluctuations, but the geometric mean falls below the arithmetic mean, and both show a greater decline than the median. The geometric mean indicates sharper month-to-month fluctuations than does the arithmetic average. The median seems somewhat erratic in months of abrupt change such as June. The data on which Figure 1 is based are given in Table I.

The geometric mean of the 20 oils and of each of the four component groups are plotted on a semi-logarithmic scale in Figure 2. The arithmetic mean of 20 industrials, as calculated by Dow, Jones, and Co. and published in Bradstreet's, is also entered upon the chart for purposes of comparison after the figures have been reduced to percentages of their average in 1919. It is to be noted that the curve for 20 oils moves in conformance with the curve for 20 industrials, but the month-to-month fluctuations for oils are more accentuated and the trend over the period shown is more sharply downward than for industrials in general. The reason for this is that the oil shares are more "speculative" than the run of items entering in the average industrials.

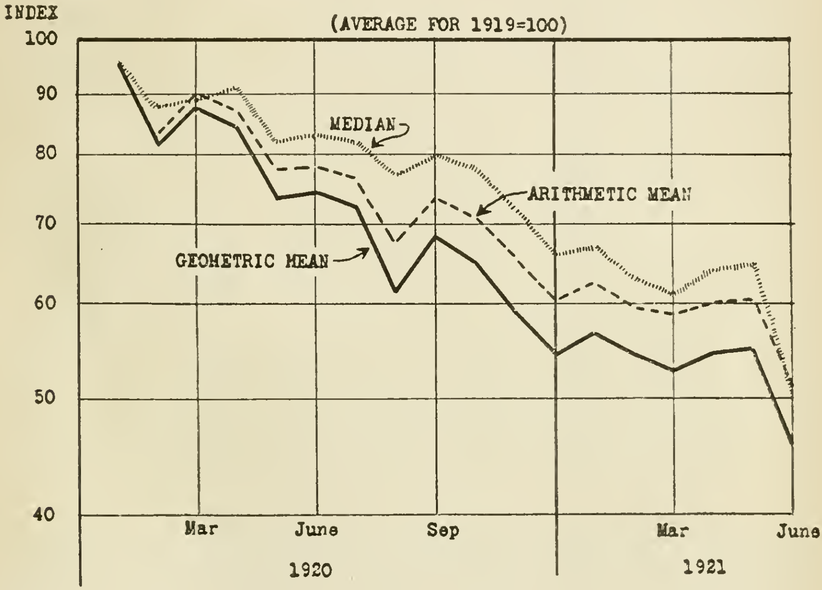

FIGURE 2.—Price of 20 oil stocks by months, 1920–21, together with prices of four component groups, compared with the price of 20 industrial stocks.

Turning next to the components of the oil average, while we recognize that five items form a rather meager sample for each group, we nevertheless observe a certain consistency. The Standard oils, representing the most stable class of oil stocks, conform very closely to the course of the 20 industrials. The foreign oils follow to some degree the course of 20 industrials during 1920, but depart downward rather sharply in 1921. The Curb oils and the New York Stock Exchange oils are next in order; the latter show the more decided month-to-month fluctuations and the greater ultimate decline from the 1919 average. Whether these relationships will be maintained will be disclosed as the indices are calculated over the months ahead.

TABLE I

PRICES OF OIL SHARES BY MONTHS, 1920–21, COMPARED WITH PRICES OF 20 INDUSTRIALS, IN PERCENTAGES OF THE FIGURES IN 1919

	Geometric mean of					Arith. mean	Median	Arith. mean
	5 Standard oils	5 Foreign oils	5 Curb oils	5 oils on N. Y. Stock Exchange	20 oils	20 oils	20 oils	20 industrials
1919:								
Year.....	100	100	100	100	100	100	100	100
1920:								
Jan.......	105.3	96.5	92.0	90.5	95.9	96.6	96	106
Feb......	94.6	86.6	78.3	69.1	81.6	83.0	88	97.0
Mar......	103.4	89.8	83.2	76.6	87.7	89.6	89	98.2
Apr......	96.4	97.8	75.2	72.5	84.6	87.1	91	99.8
May.....	86.1	94.0	60.6	60.8	73.9	77.7	82	91.3
June.....	87.4	96.1	61.4	58.8	74.2	78.1	83	92.0
July......	87.1	93.0	60.0	55.8	72.2	76.1	82	91.0
Aug......	84.9	76.9	54.6	40.9	61.7	67.5	77	85.5
Sept......	86.6	84.0	58.6	50.9	68.3	73.6	80	86.5
Oct.......	83.7	80.0	54.5	48.6	64.9	70.9	78	85.0
Nov......	80.2	70.9	51.0	42.8	59.3	65.7	72	79.5
Dec......	73.5	66.6	47.6	37.4	54.3	61.1	66	72.3
1921:								
Jan.	75.8	66.0	50.5	41.1	56.8	62.3	67	75.0
Feb......	74.2	63.4	46.7	38.8	54.3	59.7	63	76.0
Mar......	71.7	62.6	46.2	37.1	52.7	58.8	61	75.2
Apr......	73.9	62.1	46.9	41.0	54.5	60.0	64	72.1
May.....	76.4	62.8	47.7	40.1	55.0	60.5	65	77.0
June.....	67.1	53.0	37.1	33.0	45.7	51.0	50	69.3

In order to compare the price trend of oil shares with the course of commodity prices in the petroleum industry, index numbers representing the weighted average price of crude petroleum and of petroleum products are compared with the index numbers of 20 oil shares in Table II. The weighted average for crude petroleum represents five grades, and the weighted average for petroleum products is a weighted composite of individual averages for gasoline, kerosene, fuel oil, and lubricating oils.* The tabulation shows that the price of oil shares over the period shown declined independently of the trend of commodity prices in the petroleum industry, following the course of the stock market. This, of course, is normal, although it is interesting to note that the sharp advance in the price of crude petroleum and its products that characterized the first quarter of 1920 was without apparent effect upon the price of oil shares in the stock market.

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* Corresponding monthly index numbers for the entire period, 1913–21, will be found in Pogue, *The Economics of Petroleum*, New York, 1921, from which the commodity numbers shown above were recalculated.

TABLE II

COMPARISON OF THE AVERAGE PRICES OF CRUDE PETROLEUM, PETROLEUM PRODUCTS, AND 20 OIL SHARES, IN PERCENTAGES OF THE FIGURES IN 1919

	Crude petroleum	Petroleum products	20 oil shares
1919:			
Year	100	100	100
1920:			
Jan.	127	119	95.9
Feb.	131	127	81.6
Mar.	152	140	87.7
Apr.	156	143	84.6
May	158	147	73.9
June	158	152	74.2
July	159	148	72.2
Aug.	159	149	61.7
Sept.	159	149	68.3
Oct.	159	144	64.9
Nov.	158	139	59.3
Dec.	155	135	54.3
1921:			
Jan.	146	125	56.8
Feb.	97	111	54.3
Mar.	88	103	52.7
Apr.	89	101	54.5
May	80	89	55.0
June	64	86	45.7

In conclusion, the geometric mean of fixed-base relatives is employed as a satisfactory type of index number for the price of oil shares, and it is shown that the price course of oil shares in the stock market during 1920–21 followed the price trend of industrial shares in general, though registering sharper fluctuations and greater declines than the latter. Also, the price of oil shares was uninfluenced to any substantial degree by the sharp advance in the prices of crude petroleum and its products in early 1920.

ON THE APPORTIONMENT OF REPRESENTATIVES

By F. W. Owens, *Cornell University*

The problem of apportionment of representatives has its basis in the concept of the word *representative*, and whom or what he represents. For the purpose of definiteness, the problem will be restricted to the question of apportionment of representatives in the House of Representatives of the United States, except where specified. However, much of the discussion is applicable to any similar apportionment.

As applied to the United States the problem has two interpretations, one taking the question as an abstract one, free from any limitations, constitutional or otherwise, except such as may be deemed just or appropriate on their own merits, and the second treating the problem subject to the limitations imposed by the Constitution. As the latter is the interpretation used in this discussion, it is necessary to note briefly the nature of these restrictions or instructions.

The provisions of the Constitution bearing on the subject are as follows:

> Art. I. Sec. II, 3. Representatives and direct taxes shall be apportioned among the several states which may be included within this Union according to their respective numbers, which shall be determined by adding to the whole number of free persons, including those bound to service for a term of years, and excluding Indians not taxed, three fifths of all other persons. The actual enumeration shall be made within three years after the first meeting of the Congress of the United States, and within every subsequent term of ten years, in such manner as they shall by law direct. The number of representatives shall not exceed one for every thirty thousand, but each State shall have at least one Representative; and until such enumeration shall be made . . .
>
> Sec. IX, 4. No capitation or other direct tax shall be laid, unless in proportion to the census or enumeration hereinbefore directed to be taken.
>
> Amendment. Art. XIV. 2. Representatives shall be apportioned among the several states according to their respective numbers, counting the whole number of persons in each state, excluding Indians not taxed.

Aside from internal contradictions, any method of apportionment must be judged by the completeness with which it satisfies the above provisions. It is at once obvious that if "according to their respective numbers" is accepted as meaning *proportional to*, as it has always been accepted, an apportionment can rarely be made which exactly satisfies the conditions. Various approximations to such an apportionment have been used or suggested. As to the nearness of such approximations, there is no agreed standard of measurement. The language of the apportionment provision being such that exact compliance is impossible, Congress has proceeded to apportion according to what seemed to its members the nearest approach to the intent of the authors of the Constitution. These interpretations themselves have varied from time to time, but the authority of Congress to make such interpretations has never been questioned, probably on account of the provision which makes each House the sole judge of the qualifications of its members.

The first interpretation of Congress was that a number of inhabitants should be chosen arbitrarily and the population of each state should be divided by this number, and the quotient should give the number of representatives to be assigned to the state, *all fractions being neglected.* The method did not cause any disagreement of consequence until after the census of 1830, when a divisor was used which gave to Massachusetts a fraction of 0.99, and Daniel Webster argued that the phrase "according to their respective numbers" should be interpreted as "according to their respective numbers as near as may be," and that a fraction of more than one-half should entitle the state to an extra representative. His contention was not heeded in the apportionment of 1830, but in all later apportionments it has been used as a guiding principle, with minor variations. In 1840 and again in 1910, the method of an assumed ratio, as above, was used, and each state having a fraction greater than one-half was given the extra representative. From 1850 to 1900, a slightly different procedure, known as the Vinton method, was used. It differed from the above method in that first a total size for the House was chosen and the population of the country divided by the assumed size of the House, and this number (the average size of a congressional district) was then used as a divisor of the population of each state, giving for each state a whole number plus a fraction. Representatives were then assigned to the states for all of the whole numbers, and then to the states having the largest fractions, in order of size, until the total number of representatives was brought up to the assumed size of the House. One difficulty found with the method was that sometimes major fractions would not be assigned a representative by this method; in such cases Congress *arbitrarily* assigned extra representatives for such fractions, which varied the method. A lesser difficulty was that states with minor fractions sometimes received an extra representative by the method. This, however, did not seem to meet with any great objection in Congress. Another objection to the method, since known as the Alabama Paradox, is that an increase in the total size of the House may cause a decrease in the number of representatives assigned to some state when this method is used. When Congress found this to occur, a change in the total size of the House was made such that for the new total the paradox did not arise.

The method now known as the method of major fractions was devised by Professor W. F. Willcox, of Cornell University, to correct what appeared to be weaknesses in the Vinton method while preserving the general principle of allowing an extra representative for each major fraction. This was done by going back to the choice of an independent ratio, or size of congressional district, the method differing from that of 1840 only in that a method of choosing the ratio was shown which would yield any desired total size of House and keep the major fraction principle. The method is also free from the Alabama paradox. One great advantage possessed by this method, from the practical standpoint, was that it led to a priority table which showed just the order in which representatives should be assigned to the different states, up to any desired total, provided the method were used. None of the previous methods did this.

Another suggested method, which has never been used by Congress, was devised by Dr. Joseph Hill, of the Bureau of the Census, and called the method of Alternate Ratios. He contended that the extra representative should be given to a state for which the fraction exceeded that for the geometric mean between the preceding and the following whole numbers. If the true ratio (total population divided by total size of House) is used this might involve the Alabama paradox, but an *arbitrary* ratio can always be so chosen that this will not be the case. In devising this method Dr. Hill took the position that there is nothing in the problem analogous to the distribution of money. We might try to analyze this question. The Constitution puts both into the same sentence, saying "Direct taxes and representatives shall be apportioned among the several states according to their respective numbers." This would seem to indicate that the authors of the Constitution considered the problems involved to be equivalent. If one considers them equivalent, he will naturally say that the problem of apportioning any number of representatives, say 435, is equivalent to the problem of dividing a sum of money, say $435,000,000, among the states "according to their respective numbers" subject to the restrictions that the distribution must occur in lump sums of $1,000,000, and so that each state must have at least one share. In order that the share of each inhabitant should be as nearly as possible the same, the method of distribution needs be such that the mathematical expectation* of the resident of each state will be the same as that of the resident of any other state. This will inevitably give rise to some form of the major fraction method, as may be seen as follows: If r is thought of as an independent variable, the unknown population of a state, divided by this r is equally likely to give any remainder from O to $r-1$. If the arithmetic mean is taken as the point of distinction as to whether the extra representative or the extra $1,000,000 is to be assigned, the cases in which the extra assignment is made will just balance those in which it is not made, and the "expectation" of every resident will be the correct number. If the geometric mean were used, however, these cases would not balance, as the geometric mean is less than the arithmetic mean, and the expectation of the resident in the small state would exceed that of the resident of the larger state, as the difference between these means grows less as the numbers become larger. Hence, if the analogy between the distribution of money and the apportionment of representatives is granted, from the standpoint of mathematical expectation, a method based on arithmetic mean should be used.

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* The mathematical expectation is defined as the product of the probability of an event by the reward obtained in case of the event.

The Method of Equal Proportions devised by Professor E. V. Huntington* leads to exactly the same apportionment as that of Dr. Hill, provided that one uses the proper value of r (not the true value) in applying Dr. Hill's process, but his reasoning is considerably different. He uses the four equations

$$\frac{N_i}{P_i}=\frac{N_j}{P_j}; \quad \frac{P_i}{N_i}=\frac{P_j}{N_j}; \quad \frac{N_i}{N_j}=\frac{P_i}{P_j}; \quad \frac{N_j}{N_i}=\frac{P_j}{P_i}$$

as applied to any pair of states. In order to treat these four equations in the same way, he introduces a measure of variation from equality which shows the same variation from equality in all of the four cases. This measure is variously taken as the difference divided by the larger, or by the smaller, or by some average of the two numbers, which quotient gives a sort of *relative* difference. By this criterion and the further postulate that in a satisfactory apportionment there should be no pair of states which is capable of being improved by a transfer of representatives within the pair, such *improvement* being measured by his type of relative error, he is led to the priority table

$$\begin{array}{cccc}
\dfrac{P_1}{\sqrt{1\cdot 2}}, & \dfrac{P_1}{\sqrt{2\cdot 3}}, & \dfrac{P_1}{\sqrt{3\cdot 4}}, & \cdots \\[2ex]
\dfrac{P_2}{\sqrt{1\cdot 2}}, & \dfrac{P_2}{\sqrt{2\cdot 3}}, & \dfrac{P_3}{\sqrt{3\cdot 4}}, & \cdots \\
\vdots & \vdots & \vdots &
\end{array}$$

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* For details concerning this method see QUART. PUB., Sept. 1921, pp. 859–70.

and he assigns one representative to each state and then the remaining $N-48$ representatives to the states having the $N-48$ largest entries in the table, in the order of their size. As the denominators in the above table are the geometric means between the successive integers, the name "method of the geometric mean" would be appropriate, and the relationship with the method of Dr. Hill is evident. For the rest of this paper this apportionment, without regard to its source, will be called the method H.

The application of the method of least squares was made to this problem for the first time by the present writer.* For a given number of representatives, N, $\frac{N}{P}$ is regarded as the average interest of a resident in a representative. Similarly if N_i is the number of representatives assigned to a state S_i, $\frac{N_i}{P_i}$ will be the actual interest in a representative for each resident in the state S_i. The difference between these numbers represents the injustice done the individual resident of the state, or the error in his assignment. As a measure of the total injustice under a given apportionment of N representatives we may take

$$Q=\sum_{i=1}^{i=48} P_i\left(\frac{N}{P}-\frac{N_i}{P_i}\right)^2.$$

Part of the reasons for squaring the errors lie in the mathematical theory of probability and will not be discussed here. The method has a long standing in the mathematical world, both on account of its theoretical basis in probability and on account of the many useful purposes which it has served. Two strong reasons for the squaring should be at once obvious: all of the terms are thereby made positive, and the effect of over-representing one individual will not then cancel the effect of under-representing another. Also the introduction of large errors is discouraged as the square increases the relative effect of a large error. Without this squaring, even if absolute values were taken, if two individuals were under-represented, to further under-represent one and give the same amount to the other but still leaving him under-represented, would not change the total, and we wish to have every error as well as the total small.

With this basis, the problem is to choose such a distribution of the total number, N, of representatives as will make the total injustice, Q, done to all the residents of the country by the variations in their interest in a representative, as small as possible. That is N_1, N_2, ... N_{48} are to be chosen so that

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* In a paper presented to the American Mathematical Society, February 26, 1921.

$$Q = \sum_{i=1}^{i=48} P_i \left(\frac{N}{P} - \frac{N_i}{P_i} \right)^2$$

is to be as small as possible.

But
$$\begin{aligned} Q &= \Sigma P_i \left(\frac{N^2_i}{P^2_i} - \frac{2NN_i}{PP_i} + \frac{N^2}{P^2} \right) \\ &= \Sigma \frac{N^2_i}{P_i} - 2\Sigma \frac{N}{P} N_i + \frac{N^2}{P^2} \Sigma P_i \\ &= \Sigma \frac{N^2_i}{P_i} - 2\frac{N}{P} \cdot N + \frac{N^2}{P^2} \cdot P \\ &= \Sigma \frac{N^2_i}{P_i} - \frac{N^2}{P}. \end{aligned}$$

Since the last term is a constant, Q is least if

$$Q' = \Sigma \frac{N^2_i}{P_i} \text{ is least.}$$

But
$$Q' = \sum_{i=1}^{i=48} \frac{(1+3+5+ \quad . \quad . \quad . \quad \overline{2N_i-1})}{P_i}$$

since
$$1+3+5+, \quad . \quad . \quad . \quad +\overline{2N_i-1} = N^2_i.$$

Therefore
$$Q' = 2 \sum_{i=1}^{i=48} \left(\frac{.5}{P_i} + \frac{1.5}{P_i} + \frac{2.5}{P_i} + \quad . \quad . \quad . \quad + \frac{N_i - \frac{1}{2}}{P_i} \right)$$

must be least.

If we form the table

$$\begin{array}{ccccc} \frac{.5}{P_1}, & \frac{1.5}{P_1}, & \frac{2.5}{P_1}, & \frac{3.5}{P_1}, & \ldots \\ \frac{.5}{P_2}, & \frac{1.5}{P_2}, & \frac{2.5}{P_2}, & \frac{3.5}{P_2}, & \ldots \\ & . & . & . & \\ . & . & . & . & \\ \frac{.5}{P_{48}}, & \frac{1.5}{P_{48}}, & \frac{2.5}{P_{48}}, & \frac{3.5,}{P_{48}} & \ldots \end{array}$$

and choose the N smallest entries in this table and use as N_i the number of entries in the ith line, it is obvious that the quantity Q' will be as small as possible.

If we next form the table

$$\begin{array}{lllll}
\frac{P_1}{.5}, & \frac{P_1}{1.5}, & \frac{P_1}{2.5}, & \frac{P_1}{3.5}, & \cdots \\
\frac{P_2}{.5}, & \frac{P_2}{1.5}, & \frac{P_2}{2.5}, & \frac{P_3}{3.5}, & \cdots \\
\cdot & \cdot & & & \\
\cdot & \cdot & & & \\
\frac{P_{48}}{.5}, & \frac{P_{48}}{1.5}, & \frac{P_{48}}{2.5}, & \frac{P_{48}}{3.5}, & \cdots
\end{array}$$

by using the reciprocals of the entries in the previous table, and choose the N largest entries in this new table, using as N_i the number of entries chosen in the ith line, we have exactly the same distribution as before. But this second form of this priority table shows the method identical with that of major fractions proposed by Professor Willcox. The method of minimizing the sum of the squares of the errors in the interest of a resident in a representative therefore gives another logical basis for this method. For the remainder of this paper this method, as a method of apportionment, irrespective of its logical basis, will be referred to as method W. A special advantage of a criterion for the amount of injustice involved in an apportionment lies in a possible comparison of the amount of injustice involved in apportionment for different total sizes of the House. For this purpose we define

$$Q_1 = N\sqrt{\Sigma P_i\left(\frac{N}{P}-\frac{N_i}{P_i}\right)^2}$$

as the total injustice, as a function of N. If we apply this definition for the populations as they are, we find that a total size of about* 385 gives less injustice than either larger or smaller values of N for a wide range of values.†

The application of the method of Least Squares to the expression $\Sigma\left(\frac{N_i}{N}-\frac{P_i}{P}\right)^2$ will lead to the Vinton method, as was shown by the present writer in March, 1921.‡ The proof is similar to that above and will be omitted.

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* The exact arithmetic involved in this has not been carried out in complete detail.

† The idea of comparing the total amount of injustice of one apportionment as compared to that for another was first suggested by the present writer in January, 1921.

‡ Presented to the American Mathematical Society, April, 1921.

The application of Least Squares to the less significant ratios, $\frac{P}{N}$ and $\frac{P_i}{N_i}$, in the form

$$\Sigma N_i\left(\frac{P}{N}-\frac{P_i}{N_i}\right)^2$$

will minimize what might be termed the injustice to the representatives due to their having too many or too few constituents. That this method will lead to the method H was proved independently by Professor Huntington and the writer. Still other least square methods have been studied recently by Professor Huntington,* in some of which he introduces his form of relative error into the least square method, and with this form the types of expression which lead to methods H and W are interchanged.

Hence, methods H and W might perhaps be said to be the best examples of their respective types. Each is free from the Alabama paradox, and each takes care of the constitutional provision that each state must have at least one representative by assigning one representative to each state first,† arbitrarily. Each satisfies the conditions of the Constitution best when judged by its own criteria.

We must, then, in making a choice between these methods use other criteria than those contained in the methods themselves. For this purpose it is useful to examine further the implications of the phrase "among the several states according to their respective numbers." If, as is generally conceded, this means "proportional to," it carries with it the equalities,

$$(1)\ \frac{N}{P}=\frac{N_i}{N_i}; \quad (2)\ \frac{P}{N}=\frac{P_i}{N_i}; \quad (3)\ \frac{P}{P_i}=\frac{N}{N_i}; \quad (4)\ \frac{P_i}{P}=\frac{N_i}{N};$$

$$(5)\ \frac{N}{P}=\frac{\Sigma N_i}{\Sigma P_i}; \quad (6)\ \frac{P}{N}=\frac{\Sigma P_i}{\Sigma N_i} \quad (7)\ \frac{P}{\Sigma P_i}=\frac{N}{\Sigma N_i}; \quad (8)\ \frac{\Sigma P_i}{P}=\frac{\Sigma N_i}{N}.$$

All of the equations (1), (2), (3), (4), (5), (6), (7), (8) are consequences of the idea of proportionality, and will hold strictly in an exact apportionment. When integers are used they become, in general, inequalities, and for a good apportionment all the variations from equality should be small. Their deviations from equality, however, are not all of the same magnitude. Method W is derived from (1) as the most important of (1), (2), (3), (4), and in the ordinary sense makes (1) more nearly true than does method H. It also considers (5) especially important, and satisfies (5), (6), (7), (8) better than method H does, *no matter which criteria* are used. Although, in terms of its own criteria, method H satisfies (1), (2), (3), (4) better than method W does, it does not satisfy (5), (6), (7), (8) even closely. That this is the case can best be exhibited by specific illustration.

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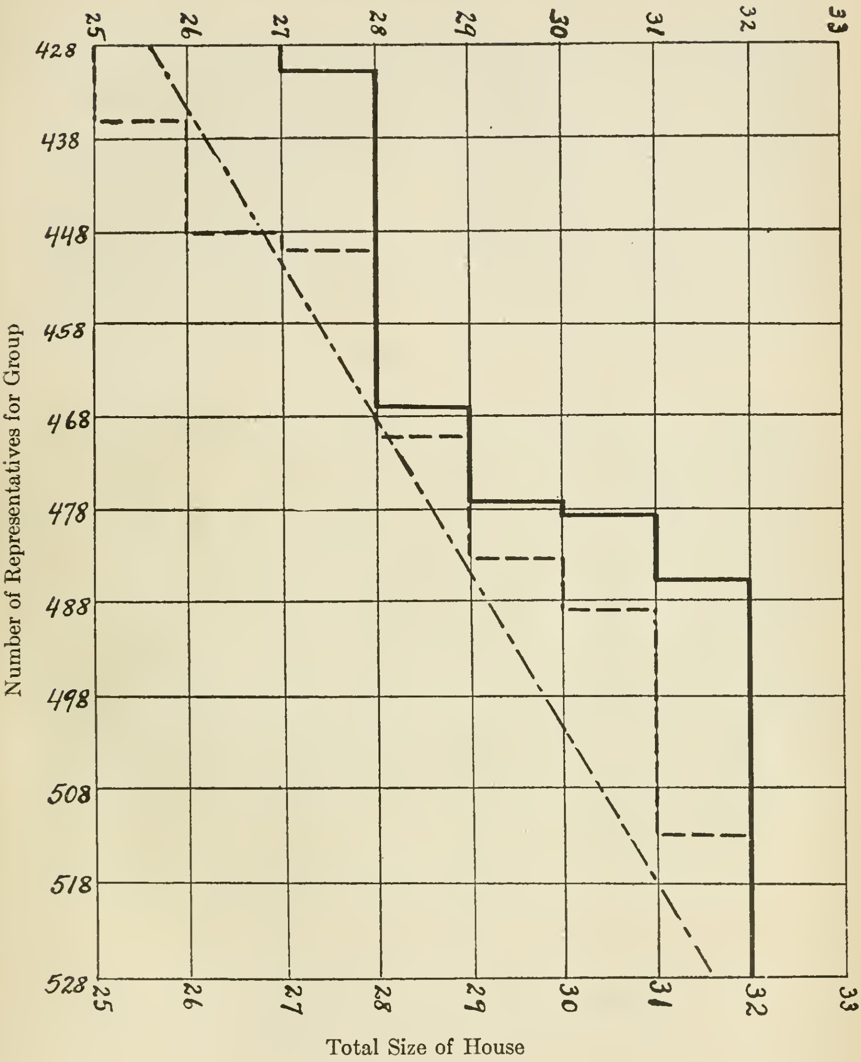
* Presented to the American Mathematical Society, September, 1921.

† If this requirement were removed the priority table for W would still serve for an analogous method, while the use of the priority table for H would lead to slightly different results according as the error is taken relative to the smaller number, the larger number, or some average of the two.

We will study the effect of apportionments H and W on the representation of a group of small states, consisting of Arizona, Vermont, New Mexico, Idaho, New Hampshire, Utah, Montana, Rhode Island, South Dakota, North Dakota, Maine, Oregon. These are all of the states having a population of as much as 250,000, and less than 800,000. The three still smaller states, Nevada, Wyoming, and Delaware, and their three representatives are omitted from the group on account of the fact that their populations are less than the size of the average congressional district, and hence their representatives are provided by special consitutional provision. The total population of this group of states is 6,310,819. This population multiplied by the total size of House (excluding 3) and divided by the total population (excluding Nevada, Wyoming, and Delaware) will give the true number of representatives to which this group of states is entitled. Under any *fair* method of apportionment the number of representatives assigned to the group would be sometimes more and sometimes less than the true number to which they are entitled when different totals are used for the size of the house, but the discrepancies would tend to average. In making the accompanying diagram, each total size of House from 428 to 527 inclusive was used, thus giving 100 apportionments including all the sizes which have been seriously considered by Congress. For these 100 apportionments, the true (fractional) number of representatives due the group of states is shown by the slanting long and short dash line. The heavy line shows the number assigned to the group by method H. The dash line shows the number assigned to the group by method W. The results may be summarized by saying that by method W the group is under-represented in 22 apportionments and over-represented in the remaining 78 apportionments. The average *amount* of over-representation being 0.47 of one representative or about 1.6 per cent of that due to the group. By method H the group is over-represented in every single one of the 100 apportionments, and the average amount of over-representation is more than 1.4 representatives, or about 5 per cent of the true number due to the group. Hence, if method H were to be used, the group of small states would be *certain* to be over-represented, no matter what the total number of the House, from 428 to 527. This over-representation is necessarily at the expense of under-representing the larger states. This constant



tendency to over-represent the small states (as a group) is inherent in method H and not an accident. The slight over-representation of the group by method W is an accident due to the small range of sizes chosen.

The only manner in which an apportionment can be made that will preserve the equal weight of each individual is by changing to a system whereby each representative would vote according to the number of his constituents. For example, a representative of a district containing

225,000 inhabitants would cast 225,000 votes on every roll call, the representative of a district containing 270,000 inhabitants would cast 270,000 votes, etc. This would seem at first sight to be a cumbrous method, but by installing electrical push buttons and automatic recording and adding devices (an innovation that should be installed in any case to save the waste of time in roll calls), the whole vote would be known instantly on any ballot. This, the only possible way of getting an *exactly* equal representation for each resident, could be carried out only by a change in the language, though not in the spirit, of the Constitution.

CONCLUSION

The question involved in the apportionment of representation is primarily one of constitutional law. The rôle of mathematics in the problem is to make clear the consequences of any given interpretation of the Constitution.

That there is an analogy between the distribution of money and the apportionment of representatives is indicated by their being grouped in the same clause of the Constitution, and on the basis of this analogy method W is to be preferred to method H.

If the intent of the Constitution is that any given population is to have the same expectancy of representation in the House as any other equal population, method H must be abandoned at once. Method W, however, fulfils this condition of equal expectancy much more nearly than does method H, and on this basis also is to be preferred.

A MEASURE OF DISPERSION FOR ORDERED SERIES*

By W. L. Crum, *Williamstown, Massachusetts*

It is the object of this paper to call attention to the inadequacy of the standard deviation for the study of the dispersion of a statistical series the terms of which are ordered relative to a given variable, to examine certain considerations bearing upon the dispersion in such series, and to set up tentatively a new measure particularly applicable to ordered series.

I. EXISTING MEASURES

A statistical series may be assigned to one of two broad classes according as it consists merely of a list of numbers of indefinite arrangement, or has its items ordered relative to a particular variable. Typical of the first class are the series composed of experimental measurements, and chief illustrations of the second class are to be found in historical series in the field of economic statistics. The common statistical coefficients have been developed in the study of, and are peculiarly applicable to, series of the first class; and it is a question of considerable moment whether such coefficients are equally useful in the analysis of an ordered series of the second class.

The chief measure of dispersion is the standard deviation, the square root of the mean squared deviation from the arithmetic mean. It is apparent from the method of calculation of the standard deviation that it can take no account of the arrangement of the variates.

Example (i). Consider the two series

(a) 3 7 4 6 2 5 8 7 3 4 7 3 5 8 2 6
(b) 2 3 2 3 4 5 5 6 7 7 8 7 8 6 3 4

obtained by arranging in two different orders the items

(c) 2 2 3 3 3 4 4 5 5 6 6 7 7 7 8 8.

The standard deviation for both (a) and (b) is the same as for (c), namely, 1.94. Nevertheless, inspection of the series (a) and (b), or a glance at their representation in Figure 1, is sufficient to reveal the striking difference between the two: (a) fluctuates violently, whereas (b) advances with fairly stable sweep. This coefficient fails, therefore, to distinguish the erratic series (a) from the fairly smooth (b).

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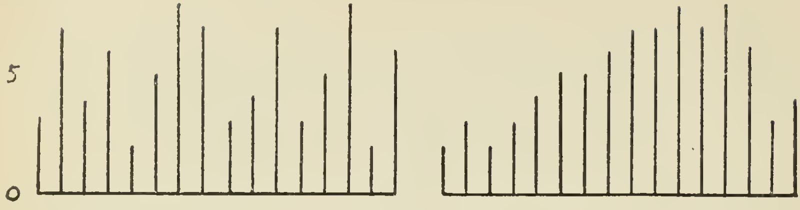
* Read before the American Mathematical Society on September 9, 1921, under the title "A tentative substitute for the standard deviation in the examination of the dispersion of an ordered statistical series."



(a) (b)

FIG I

Similar objections may be raised to the other common measures of dispersion. The coefficient of variation is derived from the standard deviation and has the same shortcoming. The computation of the mean deviation is independent of the order of arrangement of the variates, and hence it can give no better result than the standard deviation. The quartile deviation involves a grouping of the variates according to their size, regardless of the actual arrangement of the variates in their original form.

The conclusion seems warranted that existing measures of dispersion are not fitted to distinguish between such series as those of example (i). These coefficients attach the same importance to a given difference between two variates which are widely separated and two which are adjacent. They indicate the extent of the fluctuation, but fail to account for its rate. For certain purposes in the study of ordered series, particularly historical economic series, it would seem to be this very rate which it is of importance to examine and measure. Since the term *dispersion* is so widely understood in its present sense and is so generally accepted as the quality measured by the standard deviation, it may be well to avoid speaking of this rate of fluctuation as dispersion. We adopt provisionally the term *fluctuation-rate.*

II. CORRELATION COEFFICIENT

We seek now to measure the fluctuation-rate of an order series. It is suggested elsewhere* that for an ordered series possessing rectilinear trend, a more reliable measure of fluctuation than the ordinary standard deviation, σ_x, is the generalized standard deviation

$$\sigma_{x.t}=\sigma_x\sqrt{1-r^2_{xt}}$$

since this latter in effect eliminates that part of the fluctuation due to the trend. Now the quantity r_{xt} in the above formula is the coefficient of correlation between the x_i—the series being examined—and the t_i—the variable relative to which the x_i are ordered. We examine in detail below the sufficiency of r_{xt} as a measure of fluctuation-rate, and any objections found will hold also against $\sigma_{x.t}$.

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* Crum, W. L., *The Significance of the Partial Correlation Coefficient in the Comparison of Ordered Statistical Series Possessing Rectilinear Trends.* (Quarterly Publications of the American Statistical Association, Vol. XVII, pp. 949–952.)

It would seem at first glance that the correlation coefficient r_{xt} might serve as a measure of fluctuation-rate: the smaller its value, the nearer a straight line is the join of the tops of the ordinates representing the variates, and the less is the fluctuation. It is at once necessary, however, to inquire whether a series of variates does not admit of several arrangements, differing markedly in rate of fluctuation, but all having the same value for the coefficient of correlation of the x_i relative to the t_i.

In fact, if there are N variates,

$$r_{xt}=\frac{\Sigma(t_i-T)(x_i-X)}{N\sigma_x\sigma_t}$$

where T and X are the arithmetic means and σ_t and σ_x are the standard deviations of the t_i and x_i respectively. It is evident that for a given group of x_i, N, σ_t, and σ_x will all be fixed constants, regardless of the order of arrangement of the x_i relative to the t_i. The value of r_{xt} for the various arrangements will therefore depend upon the product sum

$$Np=\Sigma(t_i-T)(x_i-X).$$

Moreover, it is easily shown that this value of Np differs from

$$A=\Sigma t_i x_i$$

only by the constant, NXT. Therefore, it is sufficient to examine the various values of A which correspond to the different arrangements in order to test the adequacy of r_{xt} as a measure of fluctuation-rate.

The question now before us is: Are there several arrangements of a given group of x_i relative to the t_i, such that for all these arrangements A is identical? If it could be shown that there is only one arrangement corresponding to a given value of A, r_{xt} would indeed be an ideal index of fluctuation-rate. Or, if it develops that all the possible arrangements giving a particular value of A are such that they do not differ from one another in the character sought to be measured—the fluctuation-rate—r_{xt} would be entirely adequate to the purpose. Unfortunately, it proves that r_{xt} falls short of meeting even this second requirement.

Without attempting at present an analytical study of the above question, we can by experiment with numerical examples bring out the essential fact about the failure of r_{xt} to discriminate properly between the various arrangements.

Example (ii). Suppose the x_i consist of the intergers 1, 2, 3, to be arranged arbitrarily relative to $t_i=1$, 2, 3. The possible arrangements are:

		(a)	(b)	(c)	(d)	(e)	(f)
t_i	A	14	13	11	13	11	10
1	x_1	1	1	2	2	3	3
2	x_2	2	3	3	1	1	2
3	x_3	3	2	1	3	2	1

the value of A being given at the head of each series.

Series (b) and (d) each have A 13, and they are clearly similar in their fluctuation-rates. This is evident from the series themselves, or from Figure 2. Indeed, the nature of the fluctuation may be inferred from the two dotted triangles (this aspect of the question will be viewed more fully below), and the one triangle is obviously obtainable from the other by a succession of reflections and inversions. Similar remarks apply to the two series (c) and (e), for which A is 11.

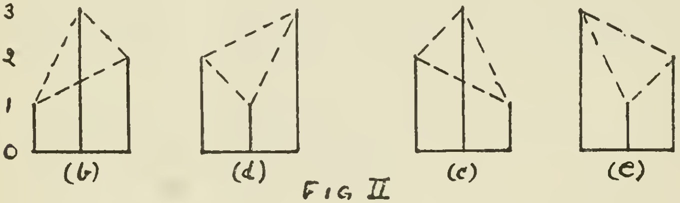

FIG. II

On the other hand, although A is 13 for (b) and 11 for (c), these two series have identical fluctuation-rates; for (c) is merely (b) in reverse order. The same is true of series (d) and (e), and the objection is even clearer in the case of (a) and (f): these pairs each have a single fluctuation-rate, but the value of A differs for the two members of the pair. It is apparent, then, that A does not have the same value for all arrangements having the same fluctuation-rate; but this is not the real question, which is whether all arrangements having the same A have equal fluctuation-rates.

Example (iii). Let the x_i be the integers from 1 to 4. The 24 possible arrangements can be classified in the following frequency table according to the value of A in the several cases:

A	20	21	22	23	24	25	26	27	28	29	30
freq.	1	3	1	4	2	2	2	4	1	3	1.

It is found, on inspection, that the series having A 20 and 30 are reverses of each other, and similarly those having A 21 and 29 are reverses in pairs, and so on throughout. Hence, the objection found under example (ii) arises here also, and in even more striking degree.

We examine next in detail the four series having A 27. They are:

(a) 1, 3, 4, 2; (b) 1, 4, 2, 3; (c) 2, 3, 1, 4; (d) 3, 1, 2, 4

and their diagrams appear in Figure 3. The series themselves and the diagrams show that (b) and (c) constitute a pair having equal fluctuation-rates, and so do (a) and (d); but the two pairs differ distinctly from each other. Of course, since they are the reverses of the above four series, the four series having A 23 are also grouped in pairs. Moreover, if we test the three series having A 29, it will be found that only two of them have identical fluctuation-rates.

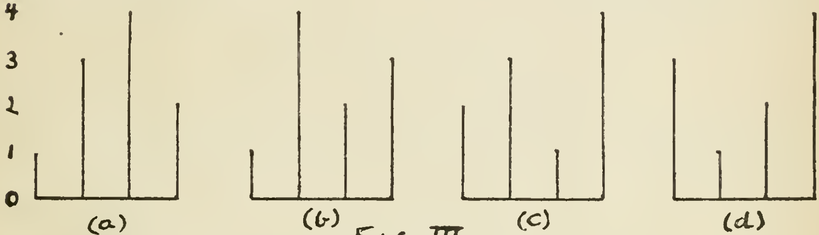

FIG III

It appears, therefore, that even for series of the simple sort given in this last example, the value of A—and hence of r_{xt}—does not furnish an adequate measure of the fluctuation-rate: it varies when the fluctuation-rate remains unchanged, and changes when the fluctuation-rate is constant. As the series become more complicated we shall have diminishing confidence in the sufficiency of the correlation coefficient for this measurement. We must hesitate even to say that it is surely better than the standard deviation; for whereas the latter gives one value for all 24 cases in problem (iii), the correlation coefficient does indeed make a distinction; but we have seen that it makes a distinction where none exists in the fluctuation-rate.

III. THE MEAN SQUARED SECOND ORDER DIFFERENCE

We recall that one way of recognizing the equality of the fluctuation-rates of two series was by the geometric correspondence of the triangles joining the tops of the ordinates. This was most apparent in the simplest case, shown in example (ii) and Figure 2. The area of the dotted triangle suggests itself as a measure of the fluctuation-rate. In a series of more than three variates there would be a series of these triangles, each belonging to three adjacent variates: for N variates there would be $N-2$ triangles. At any point of the ordered series the fluctuation-rate might be measured by the area of the triangle belonging to the three nearest variates; and, for the whole series, the fluctuation-rate would be indicated by an average of the $N-2$ triangular areas.

If we assume for simplicity that the t_i are integers, the area of the triangle belonging to three successive variates x_{i-1}, x_i, x_{i+1}, is

$$\text{Area} = \tfrac{1}{2}(x_{i-1}+x_{i+1})-x_i.$$

For series (b) and (d) of example (ii) we get for the triangular area $-3/2$ and $3/2$ respectively; and these are equal if the sign is neglected. This is in accord with our inferences from the series and the figures.

In averaging the $N-2$ triangles in a series of N x_i, we may neglect the signs and take the simple arithmetic mean, or we may take the square root of the mean squared area. We choose the latter, and have for the average area:

$$\sqrt{\frac{1}{N-2}\sum_{2}^{N-1}\left(\frac{x_{i-1}+x_{i+1}}{2}-x_i\right)^2}.$$

The type expression in this summation is the square of

$$\tfrac{1}{2}(x_{i-1}+x_{i+1})-x_i$$

which is

$$\tfrac{1}{2}(x_{i+1}-2x_i+x_{i-1}).$$

This is precisely $\frac{1}{2}$ the second order finite difference, Δ''_i. Hence the average triangular area is one-half of

$$F=\sqrt{\frac{1}{N-2}\sum_{2}^{N-1}\Delta''^2_i}$$

and, if we discard the $\frac{1}{2}$, we may take F as the new coefficient to measure the fluctuation-rate, viz., the square root of the mean squared second order difference.

We arrive at F as a measure of the fluctuation-rate by study of the deviation triangles, but the present definition in terms of the second differences gives added reason for accepting it. In fact, the first order finite difference Δ'_i is concerned with the slope of the join of two successive ordinates, whereas the second order difference Δ''_i has to do with the curvature of the join of three successive ordinates. It is this curvature, averaged over the entire extent of the series, that it is sought to measure.

It is clear that the actual calculation of F is very simple, and indeed scarcely more complicated than that of σ. Although it is necessary to calculate both the first and second differences, it is not necessary to make any correction for the position of the mean. As an example, we calculate F for the two series of example (i).

Case (a)

x_i 3 7 4 6 2 5 8 7 3 4 7 3 5 8 2 6
Δ'_i 4 −3 2 −4 3 3 −1 −4 1 3 −4 2 3 −6 4
Δ''_i −7 5 −6 7 0 −4 −3 5 2 −7 6 1 −9 10

$F=5.85$

Case (b)

x_i 2 3 2 3 4 5 5 6 7 7 8 7 8 6 3 4
Δ'_i 1 −1 1 1 1 0 1 1 0 1 −1 1 −2 −3 1
Δ''_i −2 2 0 0 −1 1 0 −1 1 −2 2 −3 −1 4

$F=1.81$

Evidently F distinguishes readily the erratic series (a) from the fairly regular (b).

We turn now to those series of example (iii) for which A is 27. The values of F for the four series are:

(a) 2.24; (b) 4.12; (c) 4.12; (d) 2.24.

We recall from Figure 3 that (c) is the "reflection" of (b), and has the same fluctuation-rate. This fact, which was not, to be sure, out of accord with the single value 27 for A, is borne out by this new coefficient. The same is true of (a) and (d). On the other hand, the distinction between the two pairs, which was not indicated by any change in A, is clearly shown by the differing value of F. Moreover, a calculation of the values of F for the four series having A 23 shows the same values as above, and the series in the A 23 group which are the reverses of (a) and (d) in the A 27 group have also F equal to 2.24, and similarly for the other pair. Similar tests apply throughout, and we may, therefore, say that both the objections raised against A are met by F.

Although we are not yet in a position to say with finality that F furnishes the best measure of the fluctuation-rate in an ordered statistical series, the tests which we have made above seem to indicate that it may be accepted tentatively as such measure. It is hoped that further study of the coefficient F will serve to develop more fully the real significance of the square root of the mean squared second order difference, and perhaps result in devising another measure even more efficacious than F.

PHYSICAL DEVELOPMENT OF VASSAR COLLEGE STUDENTS, 1884–1920

By Mabel Newcomer, *Vassar College*

It is a matter of common belief that women are growing larger. In order to ascertain whether such a change—or any change—in the physical development of women is taking place, the class in statistics of the economics department of Vassar College has made a study of the physical development of college women over a period of thirty-seven years.

The data for the investigation were obtained from records of the department of physical training, covering the period from 1884 to 1920 inclusive. Those measurements selected, upon consultation with the director of physical training, as indicative of the physical development of students, and also as comparable through the entire period, were height, weight, girth of waist, and capacity of lungs. The age and the number of sports in which the student claimed some proficiency were also tabulated as possibly offering a partial explanation of any change in development which might be found. Only the records of freshmen entering the regular academic course were used, and from these only the measurements made during the first physical examination, given shortly after the student enters college in the fall, were taken. In some instances records have been included which lack one or more of the measurements. For instance, none of the 1918 records includes the girth of waist, and in 1897 only three measurements were recorded for capacity of lungs. Consequently the frequencies vary somewhat for the different measurements. The total number of records used was 7,077, and in all of these cases the age and at least two other measurements were given.

During the earlier years, 1884–90, the examinations for each year were made by a single instructor, but not by the same instructor each year, so that there may have been slight variations in the methods of measuring employed from year to year. During the thirty years, 1891–1920, the examinations were made usually by more than one instructor in each year; but for the entire period they have been under the supervision of the present director of physical education, and there is no question as to the uniformity, and consequent comparability, of the measurements for this period.

Both the height and the girth of waist were recorded to the nearest tenth of a centimeter, and the arithmetic means were computed from tables in which the class interval was one centimeter. Weights were recorded to the nearest quarter of a pound. The measurements were grouped in classes of five pounds each for computing the mean. The capacity of the lungs was recorded to the nearest cubic centimeter, and the average was computed from a table grouping the measurements in classes of ten cubic centimeters. The averages referred to in the text are in each case the averages of five year periods because of their greater stability.

The increase in height for the period covered is considerably more than an inch. During the last thirty years the arithmetic mean has increased from 160.4 cm. to 163.7 cm., an increase of 3.3 cm. or 1.3 inches; the median has increased from 160.4 cm. to 163.6 cm. The yearly averages show an increase in excess of an inch and a half.

TABLE I

ARITHMETIC MEANS OF HEIGHTS OF VASSAR COLLEGE STUDENTS, 1884–1920

Year	No. of cases	Mean (cm.)	Standard deviation	Year	No. of cases	Mean (cm.)	Standard deviation
1884......	30	161.4	5.8	1903.......	207	163.0	5.7
1885......	39	159.7	5.0	1904.......	247	162.7	5.7
1886......	31	158.9	4.4	1905.......	208	162.1	5.5
1887......	44	161.5	4.7	1906.......	160	162.6	5.7
1888......	52	159.9	4.1	1907.......	295	162.1	5.7
1889......	59	160.7	6.0	1908.......	286	163.1	5.6
1890......	51	161.0	5.1	1909.......	260	163.2	5.5
1891......	113	160.4	5.3	1910.......	267	162.0	5.4
1892......	127	160.1	5.8	1911.......	256	163.3	5.7
1893......	129	160.3	5.5	1912.......	276	162.8	6.2
1894......	105	160.9	5.3	1913.......	296	163.0	5.5
1895......	146	160.2	5.9	1914.......	343	162.9	5.8
1896......	164	161.3	5.3	1915.......	303	163.1	5.3
1897......	201	161.2	5.7	1916.......	227	162.9	5.2
1898......	185	161.3	5.6	1917.......	241	163.6	5.6
1899......	218	161.6	5.8	1918.......	228	163.9	5.3
1900......	222	162.0	5.4	1919.......	242	163.7	5.9
1901......	290	162.3	5.8	1920.......	296	164.4	6.1
1902......	220	161.8	5.7				
				Total....	7,064	162.4	5.7

TABLE II

ARITHMETIC MEANS OF HEIGHTS OF VASSAR COLLEGE STUDENTS AVERAGED BY FIVE-YEAR GROUPS, 1884–1920

Years	No. of cases	Mean (cm.)
1884–1890....................................	306	160.5
1891–1895....................................	620	160.4
1896–1900....................................	990	161.5
1901–1905....................................	1,172	162.4
1906–1910....................................	1,268	162.6
1911–1915....................................	1,474	163.0
1916–1920....................................	1,234	163.7

The increase in weight is also marked, being six and one-half pounds in the last thirty years. The arithmetic mean has increased from

118.2 pounds in the years 1891–95 to 124.7 in 1916–20. The medians for the same periods are 117.1 and 123.4 respectively. These measurements include the weight of the examining robe, which is at present one pound and two ounces. These robes weighed slightly more in the earlier years.

TABLE III

ARITHMETIC MEANS OF WEIGHTS OF VASSAR COLLEGE STUDENTS, 1884–1920

Year	No. of cases	Mean (pounds)	Standard deviation	Year	No. of cases	Mean (pounds)	Standard deviation
1884......	30	123.8	8.7	1903.......	207	124.6	7.5
1885......	39	115.7	6.4	1904.......	246	123.1	7.4
1886......	31	114.1	5.3	1905.......	209	121.4	7.8
1887......	44	118.5	5.6	1906.......	161	124.3	7.3
1888......	53	118.4	6.6	1907.......	295	123.6	7.5
1889......	58	119.1	6.2	1908.......	282	122.4	7.9
1890......	51	117.0	5.5	1909.......	265	124.4	8.0
1891......	113	118.0	6.5	1910.......	266	122.8	7.5
1892......	127	116.6	5.4	1911.......	257	126.4	9.3
1893......	127	119.2	6.1	1912.......	277	125.2	7.8
1894......	106	117.3	6.4	1913.......	299	124.8	7.3
1895......	147	119.5	6.9	1914.......	341	122.1	6.8
1896......	164	118.9	6.5	1915.......	307	124.3	7.1
1897......	197	118.9	6.3	1916.......	227	124.5	7.0
1898......	186	118.7	7.6	1917.......	239	122.3	6.4
1899......	217	121.9	7.7	1918.......	229	124.4	6.9
1900......	223	121.9	6.8	1919.......	242	126.1	7.0
1901......	282	120.9	7.2	1920.......	296	125.8	6.9
1902......	220	121.3	7.4				
				Total....	7,060	122.5	7.4

TABLE IV

ARITHMETIC MEANS OF WEIGHTS OF VASSAR COLLEGE STUDENTS AVERAGED BY FIVE-YEAR GROUPS, 1884–1920

Years	No. of cases	Mean (pounds)
1884–1890....................................	306	118.1
1891–1895....................................	620	118.2
1896–1900....................................	987	120.3
1901–1905....................................	1,164	122.2
1906–1910....................................	1,269	123.5
1911–1915....................................	1,481	124.4
1916–1920....................................	1,233	124.7

The girth of waist does not show this regular increase. In fact there is a fairly steady decrease in this measurement from 1884 to 1904, and a regular increase from 1904 to 1920. The change in the type of clothing worn, together with the increase in weight, readily account for the recent increase; but neither of these explains the decrease of the first twenty years. The only explanation which suggests itself is that the earlier type of college woman was less subservient to fashions than those during the later years when higher education of women had become more widespread. The increase in 1916–20 over 1884–90 is just nine-tenths of an inch; and the increase over 1901–05 is nearly two inches. The arithmetic mean is 62.9 cm. for 1884–90. It drops to 60.2 in 1901–05 and rises again to 65.2 in 1916–20. The median for the same years is 62.6, 59.5, and 64.8 respectively.

TABLE V
ARITHMETIC MEANS OF GIRTH OF WAIST OF VASSAR COLLEGE STUDENTS, 1884–1920

Year	No. of cases	Mean (cm.)	Standard deviation	Year	No. of cases	Mean (cm.)	Standard deviation
1884......	30	65.2	4.6	1903.......	206	60.5	4.9
1885......	39	63.2	3.6	1904.......	248	59.0	4.8
1886......	31	62.7	6.4	1905.......	208	60.0	4.6
1887......	44	62.7	4.3	1906.......	160	61.5	5.4
1888......	53	62.9	3.8	1907.......	293	61.2	5.5
1889......	59	62.7	3.9	1908.......	283	61.0	5.1
1890......	51	62.1	4.9	1909.......	267	63.8	5.5
1891......	112	63.0	4.5	1910.......	263	63.3	5.0
1892......	127	62.6	3.6	1911.......	254	63.8	4.9
1893......	127	62.7	4.0	1912.......	274	63.9	5.2
1894......	107	62.5	5.1	1913.......	297	63.9	4.5
1895......	146	62.7	4.4	1914.......	340	65.4	4.4
1896......	160	59.6	4.2	1915.......	307	65.6	5.0
1897......	199	60.2	4.1	1916.......	227	65.6	4.7
1898......	183	60.9	4.8	1917.......	239	64.9	4.3
1899......	216	61.2	4.8	1918.......	....	....	...
1900......	223	61.0	4.4	1919.......	240	65.1	4.4
1901......	283	60.6	4.5	1920.......	296	65.3	4.1
1902......	220	60.8	4.5				
				Total....	6,812	62.7	5.1

TABLE VI
ARITHMETIC MEANS OF GIRTH OF WAIST OF VASSAR COLLEGE STUDENTS AVERAGED BY FIVE-YEAR GROUPS, 1884–1920

Years	No. of cases	Mean (cm.)
1884–1890....................................	307	62.9
1891 1895....................................	619	62.7
1896–1900....................................	981	60.6
1901–1905....................................	1,165	60.2
1906–1910....................................	1,266	62.2
1911–1915....................................	1,472	64.5
1916–1920....................................	1,002	65.2

The measurements of lung capacity are of doubtful value. The measurements of the spirometer often vary considerably for the same individual. Also, there have been changes in the type of spirometer used, and there is no record of when these changes were made. The wide fluctuations in the measurements during the earlier years, particularly from 1894 to 1898, can be attributed only to faults of measurement, probably through some defect of the spirometer. With the last twenty years, however, there is more regularity; and the same increase is apparent here that is found in the other measurements. The arithmetic mean increases from 166 cc. in 1901–05 to 180 cc. in 1916–20. The median increases in this same period from 164 cc. to 179 cc.

TABLE VII

ARITHMETIC MEANS OF CAPACITY OF LUNGS OF VASSAR COLLEGE STUDENTS, 1884–1920

Year	No. of cases	Mean (cc.)	Standard deviation	Year	No. of cases	Mean (cc.)	Standard deviation
1884......	30	177	32	1903.......	208	170	23
1885......	39	168	23	1904.......	247	169	23
1886......	31	154	24	1905.......	206	169	27
1887......	44	156	32	1906.......	161	166	26
1888......	53	148	28	1907.......	295	167	24
1889......	59	156	28	1908.......	283	169	25
1890......	51	161	29	1909.......	264	169	24
1891......	108	149	34	1910.......	265	167	26
1892......	127	164	28	1911.......	256	169	27
1893......	126	159	32	1912.......	263	168	26
1894......	107	96	36	1913.......	300	180	25
1895......	147	119	32	1914.......	339	172	27
1896......	160	117	28	1915.......	304	174	25
1897......	198	100	21	1916.......	226	179	24
1898......	3	62	10	1917.......	239	179	27
1899......	55	158	27	1918.......	225	176	26
1900......	223	159	22	1919.......	241	182	27
1901......	282	161	24	1920.......	293	182	26
1902......	218	161	23				
				Total....	6,676	164	32

TABLE VIII

ARITHMETIC MEANS OF LUNG CAPACITY OF VASSAR COLLEGE STUDENTS, AVERAGED BY FIVE-YEAR GROUPS, 1884–1920

Years	No. of cases	Mean (cc.)
1884–1890....................................	307	159
1891–1895....................................	615	138
1896–1900....................................	639	130
1901–1905....................................	1,161	166
1906–1910....................................	1,268	168
1911–1915....................................	1,462	173
1916–1920....................................	1,224	180

The very considerable increase in all of these measurements, as well as the uniformity of growth, leaves no reasonable doubt that there has been a decided increase in the physical development of Vassar College students. Accepting this, two questions at once present themselves. First, are these changes typical of all women? Second, what is the cause of such growth? Such data as are available indicate that such changes are typical of college women, at least.*

The investigation does not show why there has been such an increase, although certain conclusions may safely be drawn from the results. The mean age of entering students has decreased from 19.0 years in

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* More limited investigations were made at Stanford University and at Smith College last year. That made at Stanford University was of the heights of entering women students for a period of thirty years. (Mosher, C. D., "Concerning the Size of Women." *California State Journal of Medicine*, Feb., 1921.) The Smith College investigation covers both heights and weights, beginning with the class of 1903. (*New York Herald*, May 8, 1921.) Both of these show results for the period and measurements covered very similar to the Vassar College investigation.

1891–95 to 18.2 years in 1916–20. This fact indicates that an even greater increase in physical development would be found if the cases were grouped and studied according to age. The change in age of entrance is not great, however, and at all times is closely concentrated around eighteen years. Of the entire 7,077 cases, 6,009 fall in the three years over 17 and under 20; and 6,805 in the five years over 16 and under 21.

There is no record of race, which might have a marked influence on size, further than that offered by birthplace, which is entirely inadequate. The number of foreign born is always small, and a large part of these are of American stock.

A study of residence was made as perhaps throwing some light on the problem. It has been suggested that the number of students from western states was perhaps increasing, and that western students might be larger. Two groups were chosen: those students in college in 1890–91, which includes most of those students entering from 1887 to 1890, and those in college in 1920–21, or those entering from 1917 to 1920. The following distribution (Table IX) was found, showing a slight shift westward. These changes seem too small to be significant. Further, it might be noted that the height of the Vassar student is slightly greater throughout than that of the student at Stanford, where the proportion of western and eastern students is very nearly reversed.

TABLE IX

PERCENTAGE DISTRIBUTION OF STUDENTS ACCORDING TO RESIDENCE, 1890–91 AND 1920–21

States	1890–91	1920–21
New England	18.5	20.4
Middle Atlantic	46.4	47.0
East North Central	19.4	15.1
West North Central	4.5	4.9
South Atlantic	1.4	4.4
East South Central	4.5	1.4
West South Central	.5	.7
Mountain	.5	1.7
Pacific	4.1	2.3
Foreign	.5	2.0

The study of the number of sports in which the students engaged offers a positive contribution to the problem. Beginning in 1896 the students were asked to state in what sports they had engaged regularly before entering college, and a record has been kept of these. Although the interpretation of this question doubtless varies greatly with individuals, there is no reason to expect more cases of overstatement of the number of sports in recent than in earlier years, and the regularity and the size of the increase cannot be ignored or explained otherwise than as indicating a decided increase in the number of sports engaged in. And it seems reasonable to suppose that this is an important factor in the increase in size—how important is a matter to be determined by instructors in physical education and by others. In 1896–1900, 26.5 per cent of the students reported no sports at all, whereas in 1916–20 those reporting no sports constituted 0.6 per cent of the whole. The maximum number of sports reported by any student in the earlier period was eight; in the later, seventeen.

TABLE X

AVERAGE NUMBER OF SPORTS ENGAGED IN BY VASSAR COLLEGE STUDENTS, 1896–1920, BY FIVE-YEAR GROUPS

Years	No. of cases	Mean
1896–1900	992	2.0
1901–1905	1,167	3.1
1906–1910	1,272	3.9
1911–1915	1,482	6.3
1916–1920	1,236	9.2

Whether such increases in physical development will continue is an interesting matter for speculation: but it is for speculation only until the causes of increase are more definitely ascertained.

NOTES

METHODS USED IN MEASURING UNEMPLOYMENT

By Ernest S. Bradford*

Unemployment, as the term is used in this discussion, relates to the manufacturing and mechanical industries, including the building and hand trades, and, to a less extent, to transportation and mining. This is partly because the records kept by responsible statistical bodies in the United States are confined mainly to wage earners in manufactures and in building. The data available regarding unemployed persons in agriculture, retail and wholesale trade, domestic service, and the clerical occupations are in most instances too meager to constitute a substantial body of reliable statistics.

EMPLOYED PERSONS

In studying the unemployed it is necessary first to separate those gainfully employed into two classes, (1) employees, and (2) employers and those who are self-employed. Employees are those who work for an employer, the latter supplying the equipment, including factory, machinery, and tools, the former performing a certain part of the useful work required in the conversion of materials, and receiving for their services wages or salary. Idleness affects persons thus employed more seriously than employers or the self-employed. The farmer, the professional man, and other independent operators also frequently have greater resources than the wage earner. The seriousness of a condition of wide unemployment, therefore, is of first concern to those who are employees.

Of the total number of persons gainfully employed in 1920, amounting to between 41,000,000 and 42,000,000, according to preliminary figures based on returns from 32 states, there are possibly 30,000,000 who may properly be called employees.† Of this number between 15,000,000 and 16,000,000 are found in the group of manufacturing and mechanical industries, extraction of minerals, and transportation.

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* Mr. Bradford was a member of the Economic Advisory Committee of the President's Conference on Unemployment.

† Dr. Willford I. King estimates the number of employees in 1918 as 30,224,000, excluding about 9,750,000 entrepreneurs and the members of farmers' families who are working on their home farms. The writer's estimate is about the same for 1920, based on a detailed splitting of the occupations groups of the census into employees and others.

These are the persons whose unemployment we are particularly concerned in measuring.

MEASURING UNEMPLOYMENT

There are two principal methods of measuring unemployment: (1) the method of counting or directly estimating the number of unemployed; (2) the indirect method of estimating the reduction in the number of persons employed at certain times or between one date and another. It is assumed in the latter case that the difference between the maximum and the minimum number of employees (or persons on pay-rolls) represents the unemployed, at least at the particular time in question, or during a certain period. Figures arrived at by both of these methods were taken into account in estimating the number at present unemployed for the President's Conference on Unemployment, recently held in Washington.

The same two methods may also be used in measuring the number of unemployed over a series of years, and in arriving at the amount of normal or average unemployment. The records available in this country for a study of unemployment fall into one or the other of these two classes.

DIRECT MEASUREMENT OF UNEMPLOYMENT

The direct method of attempting to secure the number of unemployed persons has been used by the Massachusetts Department of Labor and Industries since 1908, and is based on the records of unemployment among organized wage earners. The number of labor organizations reporting to the Bureau of Statistics of the State Department of Labor and Industries includes about 250,000 members, roughly 75 per cent of the total number of union wage earners in the state. This is regarded as a large enough proportion to be typical of the organized wage earners of the entire state. The figures appear to have been collected on a uniform plan, year after year, and to be compiled with care. There is no reason to believe that the percentage of unemployment if taken in the middle instead of at the end of each quarter, or even at the end of each month, would materially change the unemployment average for the year. It is also believed that the percentage of union unemployment represents fairly well the unemployment of all industrial labor in this state—at least unemployment is not less among the non-union unskilled workers than among the organized workers, who are skilled for the most part, and who have the help of the union, when out of work, in finding a new job.

There is some evidence that the percentages of union and non-union unemployment are about the same in the leading industries of Massachusetts during the present depression. A census of the reduction in employment in textiles, boots and shoes, and metals and machinery, taken December 18, 1920, showed closely similar percentages to those of union unemployment in the same industries at the close of the quarter, December 31, 1920.

Similar figures of union unemployment in the state of New York were collected from representative labor unions each month from 1904 to the middle of 1916, when this series was discontinued and the number of employees on pay-rolls of representative factories was collected instead. The number of members of unions reporting as to idleness was gradually increased from about 100,000 in 1904 to about 200,000 in 1916, there being in 1914 about 140,000 in unions reporting. This is regarded as a large enough number to be roughly typical of industry in the state, particularly since the localities and the unions were selected with this in mind. The figures are therefore believed to be fairly representative of unemployment as a whole in New York, and also of unemployment in at least four leading industries.

In order to translate unemployment percentages into a unit which shall have significance and shall also be comparable with other percentages, it is necessary to have a definite time element present. If 10 per cent of the wage earners are unemployed at the end of each month, even though the actual persons unemployed are different from one month to the next, the average percentage of unemployment for the year is 10 per cent. It is assumed that the average of the percentages of unemployment taken at the end of each month will not differ greatly from the average of percentages taken at the middle of each month, or at any other time during the month.

The good points of the union unemployment figures of Massachusetts and New York are:

1. They have been collected regularly.
2. They have been collected by recognized statistical bureaus.
3. They have been obtained from secretaries of labor unions who are presumably well informed as to employment of members (except in the largest unions), although they are not statisticians.
4. Even if not absolutely correct, the figures represent relatively correct fluctuations from month to month or quarter to quarter.

On the other hand:

1. The figures may be exaggerated by union secretaries, giving higher unemployment estimates during depressions and lower estimates during good times than actual conditions warrant.
2. They may be intentionally exaggerated.

3. They may be too low to hold true of labor in general, since they apply only to union labor, which is skilled labor and not so often out of work as the non-union and unskilled.

These last points tend to offset one another. Further, experience in dealing with the less exact types of statistics in business and industry tends to the belief that these figures are fairly correct, especially in Massachusetts.

In using these figures it was assumed that (a) the unemployment of union industrial workers is roughly typical of general industrial unemployment in these states; and (b) these states are probably typical of other large industrial states.

Examination of the industries involved in these states does not reveal any reason to believe that unemployment would differ markedly in industries not represented.

REDUCED EMPLOYMENT AS A MEASURE OF UNEMPLOYMENT

The other principal method of estimating unemployment is to measure the differences between two or more employment levels. The state of New York, for example, since 1914 has collected figures showing the number of persons on the pay-rolls of certain representative factories, numbering approximately 1,600 plants and averaging between 500,000 and 600,000 wage earners—more than one-third of the factory workers of the state. The index number used in this method, starting with 100 per cent in July, 1914, reached 125 in March, 1920, and fell to 90 in June, 1921; 88 in July; 88.1 in August; and rose to 91.5 in September.

The state of Wisconsin has been using a similar system since 1915, and its employment curve parallels closely that of New York. About a third of the industrial wage earners of the state are represented.

The state of New Jersey has kept a record of the number of wage earners employed in its industries from 1898 up to and including 1918. These figures cover almost all of their industrial wage earners, and thus afford an excellent index of employment for that state. The figures for 1919 are not yet available because they were collected by the United States Census of Manufactures. The figures for 1920 are also still lacking.

Massachusetts takes an annual census of manufactures which shows the number of wage earners employed each month by the industries of the state. This furnishes also an employment curve of similar significance.

The Bureau of Labor statistics since October, 1915, has published in the *Monthly Labor Review* the number of persons on the pay-rolls of certain representative factories, numbering about 1,400 and representing from 600,000 to 800,000 employees. Identical establishments are compared as between any two consecutive months, but they are not identical for all the months of the year, as are the New York payroll figures. They cover 14 industries and more than 15 states, supplying information over a wider range of territory than any single state. The industries covered are well known to readers of this magazine. This supplements the data of the several states.

The method used by the United States Employment Service in January, 1921, and again in September, 1921, consisted in securing directly from certain states and cities the reduction in the number of persons reported as employed, as between January, 1920, and January, 1921. The value of this estimate naturally depends upon the care with which the figures were gathered in each state—whether by trained statisticians, and by what methods. It seems clear that information collected by a state or a federal bureau of statistics of industry or labor in a methodical and consistent manner, along lines previously found to yield dependable figures, as in Massachusetts or New York, should be regarded as more reliable than miscellaneous estimates obtained by a Chamber of Commerce or a Board of Trade, inexperienced in this field, through persons varying in statistical abilities and opportunities. Whether or not the estimate of 3,473,000 persons unemployed as of January, 1921, arrived at in this manner, is a close one depends upon the extent to which the data were collected through trained and responsible persons and on how far miscellaneous guesses were incorporated along with the estimates of properly organized statistical bureaus.

The monthly figures of unemployment published in the *Industrial Employment Survey Bulletin* (which are not to be confused with the foregoing estimate of reduced employment as of January, 1921, compared with January, 1920) and the curve which accompanies them were intended to indicate the trend of industrial employment from month to month. Pay-roll data were secured from about 1,400 concerns, usually employing 500 or more persons each, located in 65 industrial centers and representing in the aggregate 1,500,000 wage earners at the lowest point, July, 1921. The first figures in this series give the total number of workers on pay-rolls in such plants in February, 1921, compared with January, 1921, and they have been carried on currently each month since. They cover concerns in 14 groups of industries, and follow closely the census classification. They also show increases and decreases in factory employment by cities as well as by groups of industries. This method is similar to that employed in New York state and in Wisconsin, but covers a wider area and takes in only the larger concerns.

Several of these ways of measuring unemployment result in figures which agree rather closely with one another as to the extent of the reduction in employment between January, 1920, and the present time. The New York index of factory employment dropped from 123 in January, 1920, to 88.1 in August, 1921—35 points, or 28 per cent. The index of the Bureau of Labor Statistics dropped from 106 in January to 82 in July, 1921—24 points, or 23 per cent. Unemployment in Massachusetts rose from 4.1 at the end of December, 1919, to 25.9 on July 1, 1921, or 21.8 more than at the beginning of 1920.

All of these figures point to the same approximate conclusion that between January 1st, 1920, and September 1st, 1921, employment fell about 25 per cent. Applying this percentage to the 12,000,000 employees engaged in manufacturing and mechanical occupations, we find about 3,000,000 fewer factory wage earners employed in September, 1921, than in January, 1920. If we add mining, in which the reduction in employment in January, 1921, from January, 1920, was, say, 250,000, and railway transportation, in which the reduction was about 450,000, we have a reduction of 700,000 more. These figures do not take into account a considerable number of persons who were changing jobs, sick, or on strike; they represent reduced employment rather than actual unemployment, which latter is somewhat greater. Even a small addition to this 3,700,000 would bring the total up to about 4,000,000 fewer employed, not including persons in trade, agriculture, domestic service, or clerical occupations. The number which should be added from these fields cannot be estimated because of the lack of data. The increase which should be made on this account will be offset to some extent by the fact that we are measuring from an abnormally high peak, namely, January, 1920, when many persons, including women and boys not normally employed, were on pay-rolls. It is also offset partly by the fact that some persons taken off factory pay-rolls are taking other jobs and are therefore not unemployed; there is little evidence, however, that this movement has been carried as far during 1921 as many seem to believe. The evidence points to an aggregate of reduced employment of about 4,000,000 in the manufacturing industries, mining and transportation, without attempting to estimate the situations in other occupations, in which, however, there is unquestionably a much smaller proportion of reduced employment.

CENSUS OF MANUFACTURES

The figures of the United States Census of Manufactures, gathered every five years, showing in each industry the average number of persons employed on the fifteenth day of each month, or on the nearest representative day, are helpful in this connection. The available data indicate the up and down movements in employment, and hence in unemployment, in general and for particular industries during the year for which they are given. For the four intervening years between censuses, however, figures are missing.

In a general way, it may be said that the method of measuring unemployment through reduced employment—that is, from the top down—fails to include the percentage of those who are always out of work. By this is meant not the unemployable, but, as already stated, those persons (of whom there is always a certain per cent) who are changing jobs and are on no pay-roll, and those who are sick or on strike. These are not always the same individuals, but the total average percentage seems to remain fairly constant.

On the other hand, the method of measuring unemployment by considering the unemployed among organized workers—from the bottom up, as it were—tends to exaggerate the existing conditions, the secretary of the union being inclined to report fewer persons unemployed during good times than there actually are, and more unemployed than there actually are during seasons of depression. However, it is not quite correct to use the term "from the bottom up" since there is no measure of the unemployment among a great mass of unskilled and unorganized workers, who are frequently referred to as being at the bottom of industry.

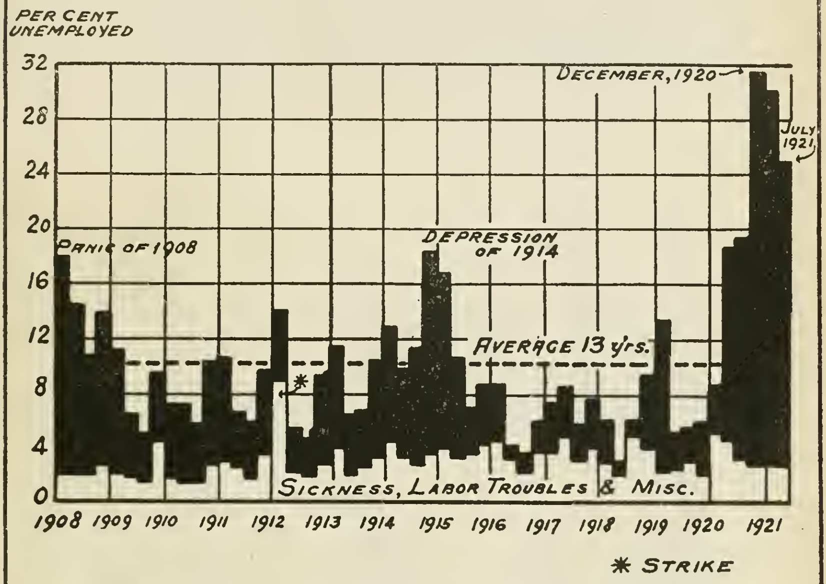
The method of measuring unemployment through fluctuations in the total number of employed entered on factory pay-rolls, as reported by the United States Census of Manufactures, is open to another objection, namely, that when all persons in industry are taken as a whole, the range from the maximum to the minimum number employed is much less than it would be if each industry were taken separately and the separate differences between maximum and minimum were then all averaged. In other words, if industry is regarded as a single labor reservoir, the range in 1914 and in 1909 between the high and the low level is only about 8 per cent; whereas if it is regarded, more accurately, as a series of smaller reservoirs, passage from one of which to another is not free, the average of the ranges runs around 15 per cent. If this process is pursued further and each plant or establishment is taken as the employing unit, which is still nearer to existing conditions—presenting, in effect, a much larger number of still smaller reservoirs or employing units of labor—the average of the difference in levels rises still higher to an undetermined number, equivalent to perhaps 20 or 25 per cent. In terms of *constant unemployment*, the percentage is about half as great as this difference between high and low.

In a large country of such extended industrial interests as the United States, the lack of adequate statistics on employment matters is surprising. Only by the most persistent and painstaking analysis can existing data be made to yield an explanation likely to fit the facts. At a time like the present when we need to know how much unemployment there is, how it compares with past unemployment, how much is seasonal, how much is cyclical or depressional, and how rapidly it is growing or waning, we are confronted with huge gaps in our statistical knowledge, to be bridged only by those who have detailed information regarding conditions in a number of particular industries. The first need, therefore, is for better unemployment data.

Suggestions for better statistics of unemployment may be summarized as follows:

1. In every industrial state records should be kept both of employees on pay-rolls and of union unemployment in order to supply an adequate basis of fact in both respects. These records should cover not only the manufacturing and building trades, but also mining, transportation and trade.
2. These figures should be collected regularly, preferably by *months* rather than by quarters.
3. They should be collected by some responsible statistical body, preferably a public bureau, organized to handle industrial or labor statistics.
4. Unemployment due to sickness and labor disputes should be separated from that due to lack of work or material.
5. The figures should show partial unemployment (part time employment) as well as complete unemployment.
6. The data should be published frequently in order to keep the employer, the employee, and the public constantly informed as to the state of business and of unemployment. There is no better barometer of industrial conditions than an unemployment index. It also acts as a warning as to the degree of social ill-being existing when men are out of work, hungry, and discontented.
7. Figures of wages and hours of work can be collected to advantage at the same time; wages multiplied by hours of employment show the wage earner's income and therefore his purchasing power.
8. Only one report or set of figures should have to be prepared by the individual employer or union. In order to reduce the burden of compiling data, when the federal government and the state both require information, arrangement should be made for one office to collect the data and supply it to the other, as is now done, for example, by the state of Massachusetts.

FLUCTUATIONS in UNEMPLOYMENT
IN MASSACHUSETTS, 1908–1921
PERCENTAGES OF ORGANIZED WAGE EARNERS UNEMPLOYED AT END OF EACH QUARTER



ABOUT 250,000 WAGE EARNERS IN 1920 WERE COVERED BY THESE REPORTS, OF WHOM ABOUT 80,000 WERE UNEMPLOYED JAN. 1, 1921.

THE HIGHEST POINT OF UNEMPLOYMENT IN MASSACHUSETTS WAS REACHED AT THE CLOSE OF 1920. IT HAS FALLEN SINCE.

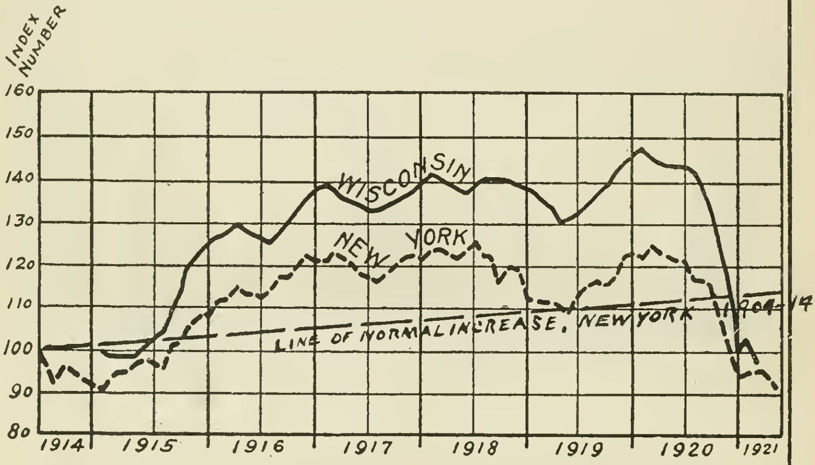
THE SHADED PORTIONS OF THE CHART REPRESENT UNEMPLOYMENT DUE TO LACK OF WORK OR MATERIAL.

The Commonwealth of Massachusetts,
Dept. of Labor & Industries
Division of Statistics

Data on unemployment are sorely needed at present, but the number of items to be secured and the labor of preparing them should both be reduced to a minimum. It is better, however, to get four items that are really needed for information than three which do not tell us what really ought to be known.

Better methods of measuring unemployment can also be worked out

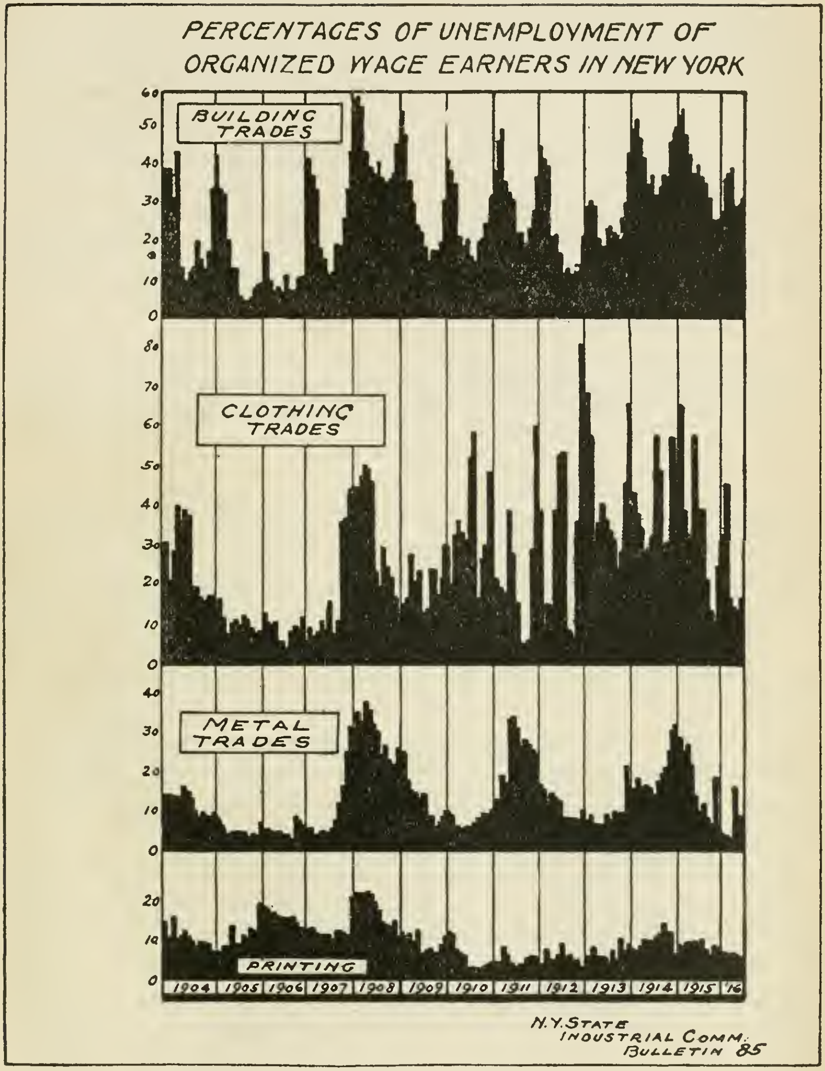
FLUCTUATIONS IN NUMBER OF FACTORY EMPLOYEES
from Pay Roll Data of
REPRESENTATIVE FACTORIES IN THE
STATES OF NEW YORK & WISCONSIN



DATA FROM
STATE of NEW YORK
DEPT. of LABOR
THE INDUSTRIAL COMMISSION
BUREAU of STATISTICS & INFORMATION
WISCONSIN STATE INDUSTRIAL COM'N

for particular industries. This should be seriously undertaken by industrial and business statisticians.

The three accompanying charts are based on data supplied by state bureaus. The first chart, showing the fluctuations in the unemployment of organized wage earners in Massachusetts, is based on data



PERCENTAGES OF UNEMPLOYMENT OF ORGANIZED WAGE EARNERS IN NEW YORK

N.Y. STATE INDUSTRIAL COMM. BULLETIN 85

and a chart furnished by Mr. Roswell F. Phelps, director of the Division of Statistics of the Department of Labor and Industries.

The second chart, showing variations in the number of factory employees in representative factories in New York and Wisconsin, is made from data supplied by Dr. E. B. Patton, chief statistician of the New York Department of Labor, and by the Wisconsin State Industrial Commission. The New York curve starts at 100 in July, 1914;

although 100 in the Wisconsin curve is as of February, 1915, the two curves are plotted in this way in order to show more clearly the similarity of movement. The line of normal increase of factory wage earners in New York State from 1904 to 1914—about 12 per cent for the five year period—is based on the figures of the United States Census of Manufactures.

The third chart, showing seasonal and other fluctuations in employment among organized wage earners in certain trades in New York State, 1904–15, is based on charts published in Bulletin No. 85 of the New York State Industrial Commission.

A METHOD OF ESTIMATING THE POPULATION OF CONTINENTAL UNITED STATES FOR INTERCENSAL YEARS

By Donald R. Belcher*

The United States Department of Commerce publishes annually in its *Statistical Abstract* a table showing the estimated population of the United States by years over a considerable period, based on the returns of the decennial censuses of population. For the years prior to that of the latest census, the numerical increase in population in any year is assumed to be one-tenth of the numerical increase shown for the decade to which that year belongs. For years subsequent to the latest census, the annual increase is assumed to be equivalent to that assumed for the years of the preceding decade. These processes of estimation may be simply described as straight-line interpolation and straight-line extrapolation respectively.

It is probably true that until the beginning of the World War these methods yielded results that were not seriously misleading. But during the war a number of influences were at work, the net result of which was to restrict population growth in the United States. Indeed, straight-line extrapolation as applied to the years between 1910 and 1920 on the basis of the censuses of 1900 and 1910 showed an estimated population for 1920 nearly two millions greater than that actually determined by the 1920 census. And now that the 1920 returns are available, straight-line interpolation is equally unsatisfactory for determining the intercensal population during that decade, since it is apparent that these restrictive influences did not become operative until 1914.

An analysis of available statistics on births, deaths, immigration, and emigration during the period from 1910 to 1920 has been found to provide a fairly satisfactory basis for estimating the population growth for the intervening years. The purpose of this paper is to present the results of that analysis and to suggest a method which can be applied to the estimation of growth during the period prior to the taking of the 1930 census.

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* Mr. Belcher is associated with the Statistical Division, American Telephone and Telegraph Company.

The population of continental United States as shown by the last three census reports was as follows:

June 1, 1900	75,994,575
April 15, 1910	91,972,266
January 1, 1920	105,710,620

In order to make this study as of January 1 of each year, the 1910 census figure was moved back three and one-half months by the assumption of a straight-line growth between the June 1, 1900, and the April 15, 1910, censuses. The result is an estimated figure for January 1, 1910, of 91,500,350. The growth in population from this date to January 1, 1920, is then 14,210,270, or an average of 1,415,109 a year.

Data on immigration and emigration are available by months since July, 1907. The annual increase in population due to excess of immigration over emigration was computed throughout the period and is shown in Column 1 of Table I.

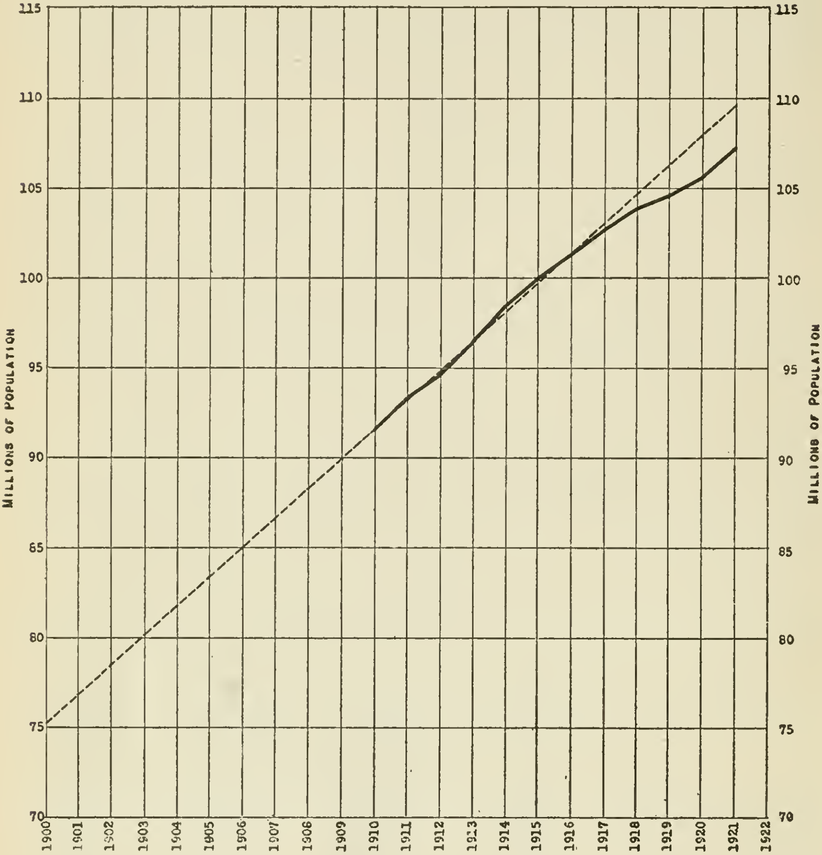
TABLE I

Calendar year	Column 1	Column 2	Column 3	Column 4
	Actual excess of immigration over emigration	Estimated deaths in United States	Estimated births in United States	Net annual increase in population
1910	763,918	1,267,101	2,281,904	1,778,721
1911	326,041	1,302,498	2,325,953	1,349,496
1912	646,742	1,308,227	2,369,106	1,707,621
1913	1,017,957	1,254,036	2,413,496	2,177,417
1914	262,853	1,289,339	2,459,644	1,433,158
1915	43,005	1,293,987	2,506,196	1,255,214
1916	263,887	1,422,182	2,534,859	1,376,564
1917	80,702	1,452,152	2,588,486	1,217,036
1918	41,471	1,888,681	2,577,299	730,089
1919	4,636	1,377,331	2,401,140	1,028,445
Total	3,451,212	13,855,534	24,458,083	14,053,761

Data on the number of deaths annually in the registration states are available since 1900. Although the number of states reporting has varied considerably, it was possible to select twenty-one identical states for which data are available throughout the decade, 1910–20. The population of these states in 1910 was 53.4 per cent and in 1920, 54.6 per cent of the population of continental United States. The corresponding ratio for each of the intervening years was estimated by

ESTIMATED POPULATION OF CONTINENTAL UNITED STATES

ESTIMATES ARE AS OF JANUARY 1ST FOR THE YEARS 1900 AND 1910-1921, INCLUSIVE. FOR PURPOSES OF COMPARISON, A STRAIGHT-LINE PROJECTION OF THE 1900-1910 GROWTH IS ALSO SHOWN.



means of a straight-line interpolation between 53.4 per cent and 54.6 per cent. On the basis of these ratios and the actual number of deaths in the twenty-one states, the total number of deaths in the United States was estimated for each of these years (Column 2, Table I). It is true that the Bureau of the Census has published annual death-rates for the registration states. But these rates are based on population estimates secured by straight-line extrapolation since 1910 and are, therefore, considerably too low. For this reason it seems preferable to use the actual number of deaths.

The determination of the number of births offers additional difficulties, since the only data available are the number of births in each of the states for the year ending June 1, 1900, and in certain registration states by calendar years beginning with 1915. Comparison of the figures for ten identical states showed that although the number of births decreased decidedly in 1918 and in 1919, the figures for the years 1900, 1915, 1916, and 1917 were fairly consistent with a constant rate of increase. The number of births was therefore estimated for the years 1910–14 inclusive by means of this constant rate. These figures, however, are for ten states, the total population of which in 1910 was 30.68 per cent and in 1920, 30.71 per cent of that of the United States. These and interpolated ratios were then used to compute the estimated number of births in the United States (Column 3, Table I).

The annual population increases due to the net results of immigration, emigration, estimated deaths, and estimated births are shown in Column 4. The total of these increases is, however, slightly smaller than the actual population increase from 1910 to 1920. In other words, this total added to the 1910 census figure gives an estimated population for January 1, 1920, of 105,554,111, or 0.15 per cent lower than that shown by the census. On the other hand, the straight-line projection method, based solely on the 1900 and 1910 censuses, gives an overestimate of 1.86 per cent, or a percentage error more than ten times as great. Furthermore, straight-line interpolation between 1910 and 1920 is unsatisfactory because, as already pointed out, it fails to take into consideration the restrictive influences in effect during the latter half of the decade.

Estimates for the years between 1910 and 1920 have, therefore, been obtained from the increases shown in Column 4 by spreading the small cumulative error over the ten years. Table II shows for each year the resulting population estimate as of January 1, and an estimated growth during the year.

TABLE II

Estimated population of continental United States

Calendar year	Population January 1	Growth during the year
1910	91,500,350	1,781,567
1911	93,281,917	1,355,186
1912	94,637,103	1,716,158
1913	96,353,261	2,188,798
1914	98,542,059	1,447,387
1915	99,989,446	1,272,288
1916	101,261,734	1,396,484
1917	102,658,218	1,239,801
1918	103,898,019	755,700
1919	104,653,719	1,056,901
1920	105,710,620	1,609,658
1921	107,320,278	....

As a matter of interest, the growth during 1920 has been estimated on the basis of actual immigration and emigration data and projected births and deaths in the registration states. This results, as shown also in Table II, in an estimated population of 107,320,278 for January 1, 1921. It is true, of course, that in applying this method to projections of future growth no information as to the trend of the ratio between the population of the selected registration states and that of the United States is available. The error involved in projecting the ratios found in the 1910–20 decade will probably not be appreciable.

The accompanying chart shows the population estimates for the years 1910 to 1921 inclusive, and a straight-line projection of the 1900–10 growth.

A SIMPLE GRAPHIC CONSTRUCTION FOR FARR'S RELATION BETWEEN BIRTH-RATE, DEATH-RATE, AND MEAN LENGTH OF LIFE*

By Alfred J. Lotka

In a previous article† the writer has discussed the rational basis of Farr's rule‡

$$\frac{1}{3}\cdot\frac{1}{b}+\frac{2}{3}\cdot\frac{1}{d}=L \tag{1}$$

where

b = birth-rate per head (2)
d = death-rate per head (3)
L = mean length of life. (4)

Writing Farr's rule in the more general form

$$P\frac{1}{b}+Q\frac{1}{d}=L \tag{5}$$

or

$$p\frac{1}{b}+q\frac{1}{d}=1 \tag{6}$$

$$(b-p)(d-q)=pq \tag{7}$$

it was shown in the paper cited how the values of P, Q (represented in Farr's formula by the approximate numerical coefficients $\frac{1}{3}$ and $\frac{2}{3}$) could be determined exactly.

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* *Papers from the Department of Biometry and Vital Statistics, School of Hygiene and Public Health Johns Hopkins University.* No. 46.

† *Quart. Pub. Am. Statis. Assn.*, Sept., 1918, p. 121.

‡ Quoted by Newsholme, *Vital Statistics*, 1899, p. 301.

In the course of some work on malaria epidemiology now in progress and to be published elsewhere later, a somewhat similar relation between certain variables was encountered, leading to the following graphic construction.

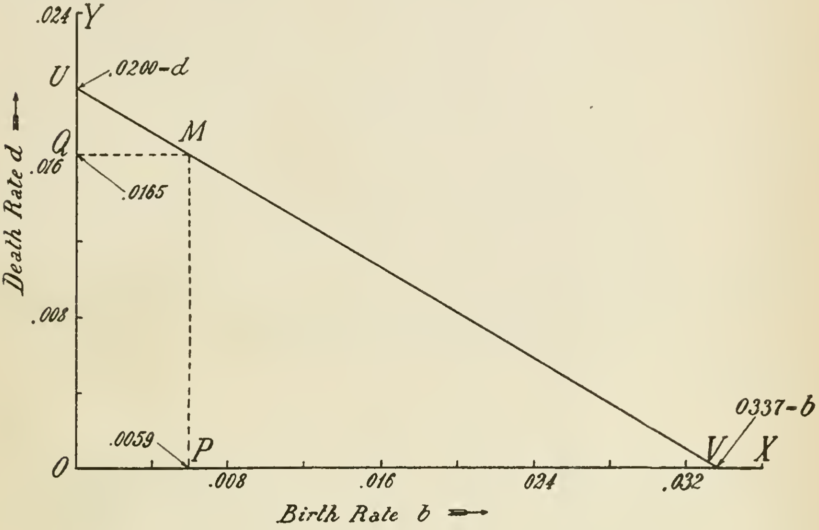

FIG. 1.

Along OX mark off a length $OP = p = \frac{P}{L}$ (8)

Along OY mark off a length $OQ = q = \frac{Q}{L}$ (9)

Complete the rectangle $QOPM$
Suppose we are now given

$$b = 0.0337 \tag{10}$$

It is required to find d
Along OX mark off $OV = 0.0337$ (11)
Join VM and produce it to meet OY in U
Read off at U on the scale of OY

$$d = 0.0200. \tag{12}$$

The figures employed in this example are those for the female population of England and Wales 1871–80, a period during which (as the writer has previously shown) the observed figures for many characteristics of the population agree very closely with those computed for a "Natural Population Norm."* In the particular instance here chosen the numerical values were

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* *Jour. Washington Acad. Sci.*, vol. 3, May, 1913, pp. 241–89.

$$P=0.2631 \tag{13}$$
$$Q=0.7369 \tag{14}$$
$$L=44.62 \tag{15}$$
$$\frac{P}{L}=0.01651 \tag{16}$$
$$\frac{Q}{L}=0.00590 \tag{17}$$

i. e.,

$$0.2631\,\frac{1}{b}+0.7369\,\frac{1}{d}=44.62. \tag{18}$$

Putting $b=0.03373$ (observed) we find (19)

$$d=0.02000 \text{ (calculated)} \tag{20}$$

as against

$$d=0.020001 \text{ (observed).} \tag{21}$$

I take this opportunity thus to supplement the data given for the male population in my previous paper. At the time it was written the extraordinarily close agreement between calculated and observed figures for the female population had escaped my notice.

A VECTOR METHOD FOR COMPUTING A WEIGHTED AVERAGE

By R. von Huhn

In terms of dynamics the arithmetic mean is the center of gravity of a distribution. To illustrate this fact we may assume that certain values represent unit weights which are suspended at intervals upon a massless rod. The ideal rod which is under the action of these weights or external forces is at rest or in static equilibrium when the forces balance each other. The location of the fulcrum is therefore the position of the average with respect to the weights.

As the weights or forces have both magnitude and direction (parallel in this case), the two essentials that are necessary for the treatment of data by vector analysis are given.

Suppose we have at hand the statistical data as shown in the following table:

Daily wage class (unit) A	The number of times each unit is encountered or weights B		Product of weight×unit C
$1	..	..	..
$2	4	R_1	8
$3	9	R_2	27
$4	3	R_3	12
$5	..	..	..
$6	5	R_4	30
	21		77
77: 21 $3.66 weighted average			

It is possible to arrive at the value $3.66 by applying the vector method and especially the funicular polygon. This brings out in a striking way the close relationship of certain dynamic principles to certain phases of the statistical science.

Column A in the table represents the unit scale from $1–$6. This scale is drawn in Figure 1 as *MN*, each unit representing one dollar =

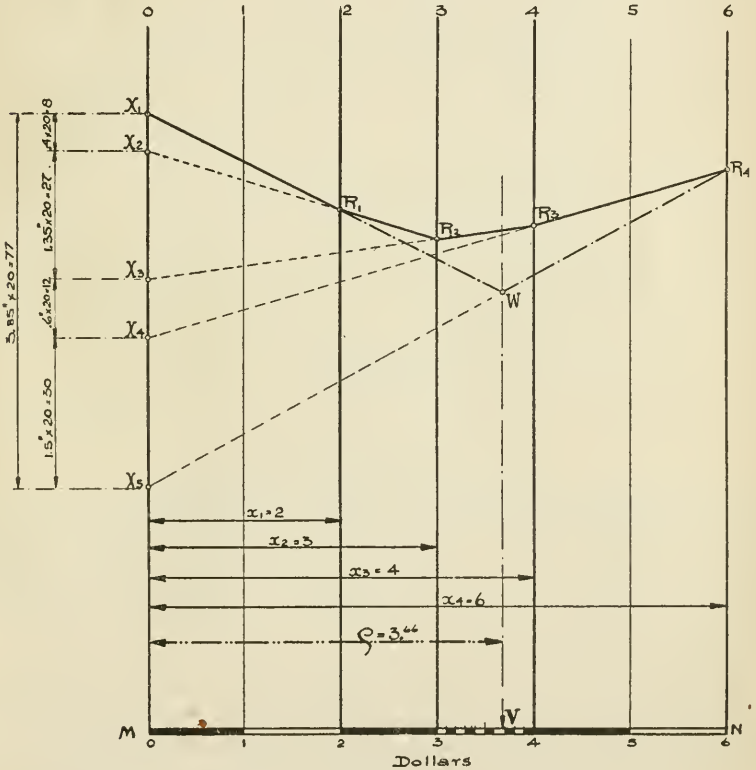

Fig. 1.

one inch. Seven perpendicular lines are drawn in each point; in 0, 1, 2, 3, 4, 5 and finally 6.

The next step is shown in Figure 2, the Polediagram. Draw a line AE parallel R_4N and choose a scale for the weights of Column B in the table. The scale chosen in Figure 2 is $1'' = 5$ dollars. Then add the vectors of the parallel forces R_1 R_2 R_3 R_4 graphically.

Then we have:

$$\begin{aligned} AB &= R_1 = 4 \\ BC &= R_2 = 9 \\ CD &= R_3 = 3 \\ DE &= R_4 = 5 \\ \hline AE &= \Sigma R = 21 \end{aligned}$$

These are the weights which have their corresponding distances from Point O such as x_1, x_2, x_3, x_4, the product of each weight and its corresponding distance giving the moments in the system. Then choose a pole distance $h=4$ inches (each inch representing 5 weights) perpendicular from the vectors. The pole distance h may be made any length desired as long as a certain scale is chosen. If Point P is connected with the points A, B, C, D, and E the polediagram is completed.

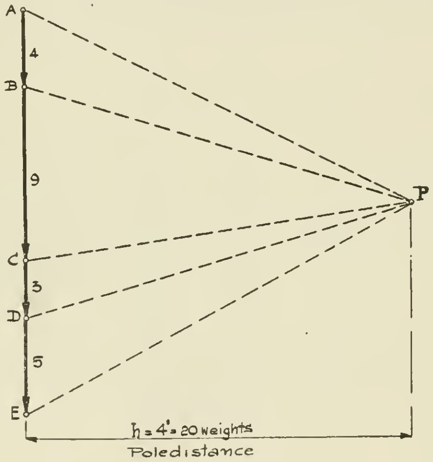

Fig 2.

Then we proceed as follows:

At an arbitrary point X draw a parallel line XR_1 to AP until it intersects with the perpendicular line $2-2$ in R_1; through R_1 draw a parallel line R_1R_2 to BP until it intersects with the perpendicular line $3-3$ in R_2; through R_2 draw a parallel line R_2R_3 to CP until it intersects with the perpendicular line $4-4$ in R_3; through R_3 draw a parallel line R_3R_4 to DP until it intersects with the perpendicular line $6-6$ in R_4.

Then draw a line R_4W through R_4 parallel to EP and extend the line X_1R_1 until it intersects with R_4W in W.

If we draw a line through W parallel to R_4N the point V will give the location of the weighted average on the unit scale MN and $MV=$ 3.66 inches = \$3.66.

Proof:

Extend R_4W until it intersects in X_5 with the perpendicular line oo
R_4R_3 " " X_4 "
R_3R_2 " " X_3 "
R_2R_1 " " X_2 "

Then $\triangle PAB$ is similar $\triangle R_1X_1X_2$

$$\therefore \; AB : h = X_1X_2 : x_1$$

hence
$$AB \cdot x_1 = h \cdot X_1X_2$$

again $\triangle PBC$, $\triangle PCD$, $\triangle PDE$ are similar to $\triangle R_2X_2X_3$, $\triangle R_3X_3X_4$, $\triangle R_4X_4X_5$ respectively.

Furthermore:

$$\begin{aligned} AB \cdot x_1 &= h \cdot X_1X_2 = .40'' \times 20 = 8.^\circ \\ BC \cdot x_2 &= h \cdot X_2X_3 = 1.35'' \times 20 = 27.^\circ \\ CD \cdot x_3 &= h \cdot X_3X_4 = .60'' \times 20 = 12.^\circ \\ DE \cdot x_4 &= h \cdot X_4X_5 = 1.50'' \times 20 = 30.^\circ \end{aligned}$$

Added
$$h(X_1X_2+X_2X_3+X_3X_4+X_4X_5) = 3.85'' \times 20 = 70.^\circ$$

$$h = 20 \text{ weights} = \text{Poledistance}$$

$$X_1X_5 = 3.85''$$

Furthermore:

$$\triangle APE \text{ similar } \triangle WX_1X_5$$

$$\therefore \; \triangle APE : \triangle WX_1X_5 = h : \rho$$

$\rho =$ distance $MV =$ Location of weighted average

hence

$$AE : X_1X_5 = h : \rho$$

$$\rho = h\frac{X_1X_5}{AE}$$

$$= 20\frac{3.85}{21} = \frac{77}{21}$$

$$\rho = 3.66 \text{ Dollars.}$$

REPORT UPON THE APPORTIONMENT OF REPRESENTATIVES*

In accordance with the request of the Senate Committee on the Census, transmitted by your letter of February 18, 1921, our committee has examined the proposed methods of apportioning representatives among the several states. We have had before us documents and correspondence furnished by the Director of the Census, by Dr. J. A. Hill of the Bureau of the Census, and by Professors W. F. Willcox and F. W. Owens of Cornell University and E. V. Huntington of Harvard University. Professor Willcox is a member of our committee, but, because he devised one of the methods considered, he does not join in this report. Professors Huntington and Owens, upon our invitation, appeared before the committee and explained the methods they had devised. We have also sought the counsel of Professor Irving Fisher of Yale University. Our conclusions may be summarized as follows:

1. The "method of equal proportions" leads to an apportionment in which the ratios between the representation and the population of the several states are as nearly alike as is possible. It thus complies with the conditions imposed by a literal interpretation of the requirements of the Constitution.

2. The "method of major fractions" has back of it the weight of precedent. Logically, however, it can be supported only by holding that the Constitution requires, not that the ratios between the representation and the population of the several states shall be equal, as nearly as is possible, but that the representation accorded to individuals or to equal groups of individuals in the population (that is, their "shares" in their respective representatives) shall be as nearly uniform as is possible, irrespective of their places of residence.

3. It is not clear that the special interpretation of the Constitution which alone is consistent with the use of the "method of major fractions" is to be preferred to other possible special interpretations which lead to other methods of apportionment. We conclude, therefore, that the "method of equal proportions," consistent as it is with the literal meaning of the words of the Constitution, is logically superior to the "method of major fractions."

In the sections which follow we explain the considerations which have led us to these conclusions.

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* This report was made by the Joint Committee of the American Statistical Association and the American Economic Association to Advise the Director of the Census in the form of a letter to United States Senator Howard Sutherland, chairman of the Senate Committee on the Census.

I. THE ALTERNATIVE METHODS

The two methods of apportioning representatives with respect to which the judgment of the committee is sought are, we understand, first, the "method of major fractions," devised by Professor W. F. Willcox in 1910 and used in the apportionment of 1911,* and, second, the "method of equal proportions," devised by Professor E. V. Huntington in December, 1920, and brought to the attention of Congress through a letter to Chairman Siegel of the House Committee on the Census.† To the "method of major fractions" there may be joined a method devised by Professor F. W. Owens in February, 1921, and named by him the "method of least errors." Professor Owens' method, it happens, although independently conceived and resting on somewhat different premises, leads to precisely the same apportionment as the "method of major fractions." It may be taken, therefore, as adding strength to the claims of that method. Moreover, Professor Huntington's "method of equal proportions" is in effect a modified form of the "method of alternate ratios," devised by Dr. J. A. Hill of the Bureau of the Census and recommended by Dr. E. Dana Durand, then Director of the Census, for adoption in 1911.‡ In discussing the "method of major fractions" we have taken into account, therefore, the suggestions of Professor Owens as well as those of Professor Willcox, and similarly we have joined Dr. Hill's suggestions to those of Professor Huntington in our consideration of the "method of equal proportions."

II. FACTORS THAT INFLUENCE A CHOICE

Judged by purely technical criteria, the method of equal proportions is superior to the method of major fractions. By "purely technical criteria" we do not mean matters of mathematical detail. Both methods are, in such respects, mathematically sound. The difference between them is one of logic rather than mathematics, of premises rather than of methods of deduction. Both methods are logically defensible. The choice between them is not a choice between the right and a wrong method. The question is a more difficult one: which of two defensible methods is the better?

We say that we base our judgment on "purely technical criteria" in order to make it clear that we have left out of account, as beyond our province and our competence, certain matters which Congress perhaps may deem important. In particular we have given no weight either to precedent and tradition or to subtleties of interpretation, such as might find in the language of the Constitution, or in the circumstances of its history, an indication that some one particular significance or meaning should be attached to apportionment ratios.

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* Cf. Report of the House Committee on the Census, 1911, 82d Congress, 1st Session, House Report No. 12, pp. 1–42.

† Congressional Record, January 19, 1921, p. 1791.

‡ Report of the House Committee on the Census, 1911, pp. 43–108.

If any weight is to be given to precedent, it will count for the method of major fractions. Professor Willcox, who devised the method used in the apportionment of 1910, has explained that his aim was "simply to provide a set of tables which would conform to the desire and purpose of Congress," as expressed in previous reports, debates, and votes upon apportionment. In the past Congress has, in fact, indicated its belief that if a state's population exceeds any exact multiple of the population of the average congressional district by a "major fraction," the major fraction gives the state a prima facie claim to another representative. The method used in the apportionments of 1840 and 1910, and now called the method of major fractions, satisfies the requirements a recognition of such claims makes as closely as is practicable.

What weight should be attached to precedent is, of course, for Congress to determine. While, on the one hand, it might be urged that if any other method is to displace the method of major fractions the other method must have a very considerable margin of superiority, it might possibly be maintained, on the other hand, that in view of the inherent complexities of the problem and the likelihood that all of its different aspects have not been presented to Congress in the past, it would be wrong to consider the case as in any degree closed. At any rate, we venture to suggest, there is one factor whose importance has increased and is likely to increase. In the past the increased representation the more rapidly growing states have gained has seldom been at the direct expense of other states. With the interests of each state thus, in a measure, safeguarded, some of the mathematical niceties of exact apportionment might be disregarded. But once the size of the House of Representatives is definitely restricted, the problem of apportionment takes on new importance. It is no longer merely a question of what states shall gain representatives. It includes also the more awkward question of what states shall lose representatives. It is possible that under such conditions Congress may hold that it is less important that the method of apportionment be based on precedent than that it should rest on the best possible logical and mathematical foundation, so as to be immune, so far as may be, from successful criticism and attack.

III. THE CONSTITUTIONAL REQUIREMENT

We do not understand that the constitutionality of either of the proposed methods is now in question, nor do we assume that the constitutionality of either of them is likely to be challenged. Both methods comply with the requirements of the Constitution in that each leads to an apportionment of representatives "among the several states according to their respective numbers." The problem merely is, which method leads to a more nearly *exact* apportionment?

The words of the Constitution are: "Representatives shall be apportioned among the several states according to their respective numbers, counting the whole number of persons in each state, excluding Indians not taxed." (Fourteenth Amendment, Sec. 2.) As we have said, we do not conceive our task to be that of constitutional interpretation. Nevertheless it is impossible to come to any conclusion respecting the relative merits of the competing methods of apportionment without careful consideration of their relation to the requirements of the Constitution. For this purpose we have taken the words of the Constitution at their face value. We have tried to avoid reading into them any implications not warranted by a rigidly literal interpretation.

For example, it has been held that these words imply that a group of individuals resident in any part of the United States is entitled to the same amount or share of representation in Congress as any other group of individuals of equal numbers resident in any other part of the United States. Or it might be held that it is implied that the population of the different congressional districts should be as nearly equal as possible. These two implications, seemingly somewhat alike, lead logically to two very different methods of apportionment. Congress might draw inferences like these from the stipulations of the Constitution. Our committee has not ventured to go that far. For a similar reason we have given no weight to the suggestion that the equal representation of the states in the Senate indicates that preference should be given to that method of apportioning representatives in the House which is more favorable to the larger states. That is clearly a matter of congressional policy, outside the field of inquiry assigned to our committee.

Confining ourselves, then, to a literal reading of the constitutional clause, we find in it two guiding principles that have an important bearing upon the problem in hand.

First, representatives are to be "apportioned among the several states." We have not thought it advisable for us to go beyond this clear stipulation by treating the problem as one of adjusting the equities of individual citizens, of groups of individuals, or of their representatives. As we have suggested, the restatement of the problem in some such manner might point to a different solution from the one we favor. In its original form (Constitution, Article I, Sec. 2), the clause in question, covering as it did the apportionment of both representatives and direct taxes, was born of an effort to adjust the conflicting interests of the different states. We have not assumed that its purpose and meaning have changed.

Second, representatives are to be apportioned among the states *according to their respective numbers.* Here we have a plain stipulation that the allocation of representatives among the states is to be determined on the basis of *proportions* or *ratios.* The ratio between the representation assigned any one state and the representation assigned any other state is to accord with the ratio between the population of the one and the population of the other. But there is no stipulation with respect to the precise way in which such proportions are to be expressed or stated.

IV. THE MEASUREMENT OF THE EQUALITY OF RATIOS

No method of apportionment, of course, can assign representatives to the several states in *exact* proportion to their respective numbers. The problem then is, in Daniel Webster's phrase, to reach a result that shall be "as near as may be" to an exact apportionment. The principal difficulty occurs just at this point. How is "nearness" to an exact apportionment to be measured? How is the difference between two states with respect to the relation between their representation and their numbers to be determined? These questions are included, in part at least, in a larger problem—how is the "nearness" of any two numbers to be determined?

The "nearness" of two numbers may be measured either *absolutely* or *relatively.* For example, which are nearer, the numbers 3 and 5, or the numbers 45 and 50? The absolute difference between 3 and 5 is only 2, while between 45 and 50 it is 5, so that by this test 3 and 5 are "nearer" than 45 and 50. But while 3 is 60 per cent of 5, 45 is 90 per cent of 50, so that *relatively* 45 and 50 are "nearer" than 3 and 5. Suppose that state A is given 20 representatives, its exact quota being 20.6, while state B is given 2 representatives, its exact quota being 2.4. Which state is nearer to its exact quota? Absolute nearness is closer in the case of state B, since 0.4 is smaller than 0.6; but relative nearness is closer in the case of state A, since state A has 97 per cent of its exact quota, while state B has only 83 per cent. Expressed in this manner, the measurement of "nearness" by absolute differences leads to the method of major fractions, while its measurement in relative or percentage terms leads to the method of equal proportions.

For the general problem of the measurement of the "nearness" of two numbers, there is no single exclusive solution. The appropriate method must be determined by the nature of the concrete problem in hand. For example, temperatures of 5 degrees and 10 degrees above zero are "nearer" than are temperatures of 90 degrees and 100 degrees. But a firm with assets of $50,000 and liabilities of $100,000 is further from solvency than a firm with assets of $900,000 and liabilities of $1,000,000.

Although the problem of the best method of measuring the "nearness" of *numbers* is thus, as a general problem, ambiguous, such is not the case with respect to the "nearness" of *ratios* or proportions. A ratio between numbers is not itself a quantity, yet there is no way of measuring the absolute difference between ratios, except by putting them into the form of fractions and treating them as numbers or quantities. In order that a ratio may be treated as a fractional quantity, certain assumptions must be made which may not, in a particular case, be warranted. But ratios may properly be compared, *as ratios*, with respect to their *relative* "nearness." Thus to say that the ratio between 2 and 4 is $83\frac{1}{3}$ per cent of the ratio between 3 and 5, is merely to say that the first ratio is related to the second ratio as the ratio between $83\frac{1}{3}$ and 100 is related to the ratio between 100 and 100.

The problem in hand, or rather so much of that problem as we take to be within the field of our inquiry, is to determine which of the methods under review will give an apportionment of representatives that will be, "as near as may be," in accordance with the populations of the several states. This is a matter of making ratios or proportions as nearly alike as possible. For the reasons we have outlined the alikeness or nearness of ratios is best measured in relative terms. This is one ground on which technical superiority must be assigned to the method of equal proportions.

V. DIFFERENT WAYS OF EXPRESSING RATIOS

When apportionment ratios are expressed as fractions, further difficulties appear. Such fractions may take several forms. For example, their numerators may express the number of representatives to be assigned the several states, and the denominators their populations. Or population may form the numerator and the number of representatives the denominator. Or, again, the representation of any two states may be compared by means of a pair of fractions. One fraction has for its numerator the population of one state and for its denominator the population of the other. The other fraction has for its numerator the number of representatives assigned the first state, and for its denominator the number of representatives assigned the other.* Which among these different sets of fractions is to be selected?

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* Denoting the number of representatives assigned to states A and B by a and b, and their respective populations by A and B, there are the following possible classes of fractions: (1) a/A, b/B, etc.; (2) A/a, B/b, etc.; (3) A/B, a/b, etc.; (4) B/A, b/a, etc.

If the method of equal proportions is used, the choice is a matter of indifference. Any or all of the possible forms of fractions will lead to the same apportionment. That is, the apportionment which will bring one set of fractions "as near as may be" to equality, will also minimize the differences in the other sets of fractions. This is because when the "nearness" of ratios is measured on a relative scale, the results do not depend upon the particular form of the fractions by means of which the ratios are expressed.

When, however, the "nearness" of fractions is measured by their absolute differences, so that the fractions are treated as quantities rather than as merely expressing ratios, the form of the fraction used in the comparison becomes a matter of importance. The measurement of "nearness" by means of absolute differences does not of itself lead to the method of major fractions. That method requires the further assumption that the significant fractions are those in which the numerators denote representatives and the denominators population. Inverted, so that their numerators denote population, and with their "nearness" measured by their absolute differences, these fractions lead to a very different scheme of apportionment, which, on mathematical (though not on historical) grounds has an equally valid claim to the name, method of major fractions. The method of equal proportions, it is interesting to note, gives results that are intermediate between those given by these two ways of measuring "nearness" by absolute differences. It is somewhat more favorable to the small states than is the method of major fractions and somewhat more favorable to the large states than that method would be if it made use of the other form of fractions.

On purely mathematical grounds there is no reason to prefer one of these two forms of fractions to the other. The two are equally valid as expressions of apportionment ratios. It thus appears that unless other than mathematical reasons can be found for preferring one form of fraction, the method of major fractions encounters the formidable objection that it leads to results that are self-contradictory.

If preference is to be given to one form of fraction, it can only be because different *meanings* are attributed to the different forms. Now as long as these fractions are construed merely as expressing ratios, there can be no difference in their meanings. To state that the ratio of representatives to population is as 1 to 240,000 is to state that the ratio of population to representatives is as 240,000 to 1. A familiar example may make the matter clear. The speed of a railway train or of an aeroplane is stated in terms of miles per hour; the speed of a runner in terms of minutes per mile. The meaning is the same in both cases: the ratio between the two magnitudes: distance traversed and time elapsed. Science, it is true, has adopted the convention of expressing the time-distance ratio as a fraction in which distance is the numerator and time the denominator. But this is merely a matter of convenience. In inverted form the ratio, *as a ratio,* would have the same *meaning.*

If distinctive meanings, therefore, are to be attached to the different forms of fractions which express apportionment ratios, they must be construed to be something more than mere ratios. This construction may be accomplished by using common denominators or by reducing the denominators to unity, so that the numerators become the quotients of the original numerators divided by the original denominators. To the numerators, taken by themselves, concrete meanings can be attributed. Thus, the number of representatives assigned to a state divided by a number representing its population gives a number which may be interpreted as the "average representation accorded to an individual in the state's population." Similarly, the quotient obtained by dividing the state's population by a number corresponding to the representatives assigned it, may be construed as "the average size of a representative's constituency," or "the average size of a congressional district within the state."

So far as mathematical considerations are concerned, the processes by which one meaning or the other is imputed to apportionment ratios are wholly arbitrary. If the method of major fractions is to be supported, it must be by holding that what the Constitution requires is, after all, not that the ratios of representatives and population shall be equal "as near as may be" for the several states, or even that the average size of congressional districts shall be as equal as possible as among the several states, but that the differences in "the representation accorded an individual" shall be minimized. The absence of any clear reasons (save those of precedent) for emphasizing the "representation accorded an individual" rather than "the size of an average congressional district," or either of them rather than that simple proportioning of representatives according to population which the constitutional clause, taken at its face value, seems to require, establishes the second ground on which the method of equal proportions is to be preferred to the method of major fractions.

VI. THE USE OF SQUARES IN THE METHOD OF LEAST ERRORS

Professor Owens has shown that the apportionment which will make the sum of the squares of the errors (*i. e.*, the differences between the actual share a citizen of a state has in his representative and the exact share to which he is "entitled") a minimum will be the same apportionment as would be reached by the method of major fractions. This result affords additional evidence that results which the method of major fractions gives are logical deductions from the premises of that method, and possibly makes the logical premises of that method somewhat clearer. But this use of the method of least squares does not strengthen the claims of the method of major fractions as against the method of equal proportions. The "errors" whose squares Professor Owens seeks to minimize correspond to those "absolute differences" which are less appropriate measures of the "nearness" of apportionment ratios than are the relative differences utilized in the method of equal proportions. Moreover, the method of least squares is applicable to any of the forms of fractions which may be used to express apportionment ratios, and thus leads to self-contradictory results. In short, as used by Professor Owens it not only presupposes the validity of absolute differences, as a measure of "nearness," but it also requires, as Professor Owens himself suggests, that only one of the possible types of fractional expression of the apportionment ratios shall be utilized.

VII. SUMMARY OF CONTROLLING CONSIDERATIONS

1. It is clear that the Constitution requires that the allocation of representatives among the several states shall be proportionate to the distribution of population. It is not equally clear that there is anything in the constitutional requirement which suggests that one of the forms in which such apportionment ratios or proportions may be expressed should be preferred to another.

2. The method of major fractions utilizes only one of several ways of expressing apportionment ratios. The method of equal proportions utilizes all of these ways without inconsistency. The latter method, therefore, has a broader basis.

3. There is no mathematical or logical ground for preferring the one form of expression of the apportionment ratio used in the method of major fractions to other forms of expression. These other forms lead, when similar processses of computation are employed, to different and therefore inconsistent results.

4. The method of major fractions logically implies preference for a special meaning which may be attached to one of the forms in which apportionment ratios may be expressed. To attach to ratios meanings which vary with the forms in which the ratios are expressed is to interpret them as something else than ratios.

5. In the method of major fractions the "nearness" of the ratios

of representatives and population for the several states is measured by absolute differences. The method of equal proportions utilizes relative differences. The relative scale is to be preferred.

Respectfully submitted
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A NATIONAL INDEX OF RETAIL TRADE

The Federal Reserve system is at present receiving monthly reports from about 350 department stores, located in all sections of the United States. The statistics obtained from these stores are as follows: percentage change of net sales from sales in corresponding month of previous year, percentage change of stocks from corresponding month of previous year, percentage change of stocks from previous month, and ratio of outstanding orders at close of month to total purchases in previous year.

Indices for these items have been published for each of the twelve Federal Reserve districts since August, 1920, but no national index was made previous to August, 1921. At that time a national index was constructed by combining weighted percentages for the several districts. These weights were secured by finding the percentage distribution of population and of banking resources, respectively, in 1920, among the Federal Reserve districts. A weight is obtained for the retail trade of each district in its relation to the retail trade of the nation by multiplying the population percentage of the district by two and adding the district's percentage of total banking resources.

The monthly comparisons of changes in retail sales and stocks since August, 1920, for the United States are shown in the following table:

TABLE I
CHANGES IN VOLUME OF SALES AND OF STOCKS IN COMPARISON WITH CORRESPONDING MONTH IN PREVIOUS YEAR

	Sales Per cent	Stocks Per cent
1920		
August	+21.2	+37.0
September	+13.6	+28.2
October	+10.0	+26.4
November	+13.4	+16.7
December	+ 3.1	+ 6.2
1921		
January	— 4.7	— 9.4
February	+ 0.8	—14.4
March	— 3.0	—17.9
April	— 4.2	—18.9
May	— 8.6	—17.7
June	—10.7	—17.4
July	—15.1	—19.1
August	—11.9	—19.0

There seems to be a moderate degree of direct correlation between these two series, but it must be remembered that the figures are comparisons with the corresponding month in the previous year, and are consequently not a sensitive measure of changes from month to month.

As monthly changes in size of stocks are available, it is possible to construct an index of stocks for the entire period on a fixed base. In Table II this index of stocks is compared with the ratio of outstanding orders to purchases in the previous calendar year (it should be noted that the base of this second series changes in January, 1921):

TABLE II

COMPARISON OF STOCKS WITH OUTSTANDING ORDERS

Close of	Value of stocks (July, 1920=100)	Ratio of outstanding orders to purchases in previous calendar year
1920		
August	107.8	15.9
September	116.0	11.9
October	117.1	7.1
November	111.2	5.5
December	87.0	5.1
1921		
January	80.6	7.0
February	84.7	8.1
March	90.4	6.2
April	92.1	6.0
May	89.9	5.5
June	86.0	6.4
July	84.4	8.4
August	90.0	8.3

These figures indicate that orders tend to increase when stocks are declining, and to decrease when stocks are accumulating, but the data are insufficient to furnish definite conclusions concerning the average lag of this inverse correlation.

In conclusion it should be stated that national indices of retail trade are as yet in only a preliminary form. As soon as data are available from all sections of the country in dollar amounts instead of percentages, it will be possible to construct series of relatives with a uniform base period which will warrant a more extended analysis.

LAWRENCE B. MANN

PROGRESS OF FOURTEENTH CENSUS WORK

Probably few persons other than those connected with the census realize the magnitude of the undertaking and the difficulties of carrying it to completion within the period prescribed by law. It involves the printing and distribution of 25,000,000 schedules of questions; the organization and supervision of a force of over 90,000 enumerators and special agents employed to make a house-to-house canvass of the entire United States—including all the outlying possessions except the Philippines and the Virgin Islands—and to fill out schedules for 107,500,000 people, 6,500,000 farms, 450,000 manufacturing establishments, and 22,000 mining and quarrying enterprises; the examination, checking, and editing of the schedules when received; the punching of 300,000,000 tabulation cards; the running of the equivalent of over 2,500,000,000 cards through electrical sorting and tabulating machines; the computation of about half a million percentages, averages, and other ratios; the preparation of elaborate manuscript tables; and, finally, the printing and publication of 11 quarto volumes of about a thousand pages each. Despite the size and complexity of the undertaking, and despite the unusual obstacles which impeded the enumeration and delayed the commencement of the tabulation, the stage of progress now reached is such as to afford a substantial basis for the hope and expectation that the Fourteenth Decennial Census work will be completed within the three-year period prescribed by law—ending June 30, 1922— at least to the extent of having the manuscript for the last of the reports in the hands of the printer before the close of the period. The field work and the checking and editing of the schedules, the card punching, and the machine sorting and tabulating have already been completed.

For the first time in the history of the census the agricultural and manufactures data are being completely tabulated by punch cards and electrical tabulating machines. The machinery employed differs essentially from that used on the population work, however. In one case it is necessary to count units, and in the other to add numbers. Therefore, the machines used for the population census are essentially unit-counting machines, while most of those for the agricultural and manufactures work are integrating machines. In the agricultural work 17 sets of punch cards are used, and in the manufactures work 12 sets.

PUBLICATIONS ISSUED OR SOON TO BE ISSUED

Volume I—Number and Distribution of Inhabitants.—This volume, which was issued August 30, 1921, represents a radical departure from the plan of publication of the Thirteenth Census results. It presents all the census statistics as to total population—that is, population not classified as to sex, age, color, etc.—giving the population of each state and of its counties, cities, townships, and other minor civil divisions. The population of cities having more than 5,000 inhabitants is also shown by wards in all cases where the enumerators' returns make this possible.

The bulk of the volume is made up of six detailed tables giving the population of counties, incorporated places, and other minor civil divisions. The urban and rural population of counties is shown separately. The final table gives the population, by minor civil divisions, of the several outlying possessions covered by the census. Preceding the detailed tables is a summary section consisting of 48 summary tables, explanatory text, and maps and diagrams.

Thus this volume presents all the Fourteenth Census population statistics in which the great majority of users of census figures are interested; and it has been published at a much earlier date, relatively to the date of the enumeration, than any of the Thirteenth Census volumes.

Volume III—Composition and Characteristics of the Population, by States.—This volume will consist in the main of the material contained in the several state bulletins on composition and characteristics of the population, and will correspond, as far as the composition and characteristics statistics are concerned, to Volumes II and III of the Thirteenth Census reports. Those volumes, however, also contained statistics on number and distribution of inhabitants, corresponding in a measure to those presented in Volume I of the Fourteenth Census reports. In addition, Volume III will include a section giving figures for the United States as a whole, in which the plan of presentation of the statistics will be similar in general outline to that followed in the various state sections. This United States section, which will also be published as a separate bulletin, will present all the composition and characteristics statistics desired by most persons who make use of this class of statistics. No such section appeared in the corresponding volumes of the Thirteenth Census reports. The issuance of state bulletins on composition and characteristics of the population was completed November 17, 1921; and Volume III is now in process of printing.

Volume VI—Agriculture: Reports for States with Statistics for Counties.—This volume will correspond to Volumes VI and VII of the Thirteenth Census reports, and will be issued in three parts, one presenting statistics for the North, one for the South, and one for the West. In addition to the state sections, each identical with the corresponding state bulletin, Volume VI—like Volume III, for population—will contain a section relating to the United States as a whole. No such section appeared in the corresponding volumes of the Thirteenth Census reports. The manuscript for this volume is now in the hands of the printer.

Volume VII—Irrigation and Drainage: General Report and Analytical Tables, and Reports for States, with Statistics for Counties.—This volume, as its title indicates, will consist in part of a general report, covering all sections of the country in which irrigation and drainage enterprises are in operation, and in part of a set of reports for individual states, these state reports being identical with the corresponding state bulletins. Volume VII is now in process of printing.

Press Summaries.—At the Fourteenth Census the Bureau has published its detailed statistics—those pertaining to race, age, illiteracy, nativity, occupational classes, farm acreage, crops, wage earners in manufacturing establishments, value of manufactured products, etc.—in the form of press announcements to a greater extent than has been done heretofore, the purpose being to make public all the census statistics at the earliest possible date. First, press summaries pertaining to certain subjects for individual cities are issued—for example, illiteracy in Chicago, school attendance in Philadelphia, and age distribution in Richmond. As soon as the statistics pertaining to a particular subject for an entire state have been compiled, a state summary is issued; and when the compilation is completed for the entire United States, a final summary for the country as a whole is made public. In this way not only the basic census results but also the detailed statistics are being made public through the medium of the press in the localities to which they relate.

SHOULD THE UNDERGRADUATE BE TRAINED IN ELEMENTARY STATISTICAL METHODS?

Industrial history has been introduced into the high school. Elementary economics is now being taught to sophomores in college. Professional training begins during the last two years of the undergraduate course. The student is taking special courses in applied economics and social science and his background has widened to include a varied assortment of facts which are alleged to describe or measure the phenomena of community life. What was formerly post-graduate or professional study is now under way before the student reaches the more specialized and technical training of his post-graduate course.

Training in method of approach to a problem, acquaintance with the tools needed in his work, familiarity with principles according to which his sources of information may be judged—these are fundamental matters in the education of students of the social sciences, theoretical and applied. Yet these considerations are neglected by many colleges which have shown a rapid development of courses in this field.

Technique and methods in the natural sciences have been well developed and applied in the laboratory by the student beginning the subject. But many students of social science have not mastered a natural science and, therefore, have not acquired the discipline in methods of assembling data and sifting evidence, nor have they acquired the habit of independent and cautious generalization from known facts.

Furthermore, they leave behind them, early in their course and usually with light hearts, the exact methods of their mathematical studies because they do not expect to apply them. *Algebra,* which has aided in solving the unknown from the known, *logarithms,* which have proved effective tools in computation, the *characteristics of lines and curves,* which are utilized today very effectively to describe the phenomena of social and industrial life and to illuminate their explanation—all these are forgotten because the student, as he begins his studies in the social sciences, has not been shown their significance in his work. It is only after he has forgotten and when there is no time to repair the loss that the professional and research worker faces the need for this mathematical equipment. The engineer has no such trouble with his technical training because he understands what is necessary from the beginning.

Admitting, for the sake of argument, that the above statement of the situation is essentially true, why give the social science student statistics as a remedy? This is a fair question, and an answer should and can be given. The training in statistics must not be conceived in any narrow or professional sense, but as a discipline in scientific method. It is concerned with a body of principles and methods developed to guide the student in the collection and treatment of quantitative data relating to groups or aggregates. Laboratory experience with such data places proper emphasis upon the essentials of scientific method, *i. e., a knowledge of facts which have been classified, an appreciation of their sequence, and a judgment as to their relative significance.* Statistics, regarded as a method of investigation, involves exact measurement, a careful record, intelligent grouping, discriminating analysis, and weighing of evidence.

Especially in the social sciences, where factors are complex and human sympathies are keen, it is difficult to free our judgments from the peculiarities of the individual mind. The scientific attitude of mind prompts the student to seek evidence which will appeal to others than himself as true.

The junior or senior in college who is majoring in the social sciences has acquired a background of interesting facts, many of them expressed in quantitative form. He has concrete evidence of the dynamic character of social and economic life, the constant changes which render his judgments and conclusions relative to time and place. Using this background of facts, it is possible to develop a scientific attitude of mind in the approach to social and economic problems. The training in statistical methods and practice may be made a means to this most desirable end. *Statistics may serve a purpose for the social sciences similar to that which the laboratory serves in the natural sciences.* If offered to the undergraduate at the threshold of his professional training it will gather together and preserve as useful many of the exact methods of mathematics by showing their application to the data in his field of study. In some respects the college senior is in a much better position to study and profit by statistical methods than the present graduate student.

Finally, to read and appreciate the literature in his field, and to consult intelligently the sources of information, many of which are in quantitative form, the student of the social sciences, theoretical and applied, needs some training in statistical methods. Figures may speak for themselves, but not necessarily the truth. The student faces masses of quantitative data in so-called statistical reports, and he requires some principles by which he may judge their credibility and adequacy for his purposes. Quantitative statements do not usually bear on their face the stamp of their credibility. The independent student must be skeptical of his own facts and those produced by others.

If the undergraduate is trained in the elements of statistical method the way will be clear, when he enters a business school or a graduate department, to take up at once the research problems of his chosen field without having to acquire for the first time a knowledge of tools and methods in the use of which he already should have acquired skill.

ROBERT E. CHADDOCK
Columbia University

EUGENICS CONGRESS

The Second International Congress of Eugenics which recently has completed its sessions at the American Museum of Natural History, had a far larger and more enthusiastic attendance than was foreseen. The congress was planned with certain major policies in view. The first of these involved the presentation to those attending the congress of a large body of biological facts which might serve as a firm foundation upon which any theoretical treatment of eugenics should rest. Scientific communications dealing with human and comparative heredity formed, therefore, the first section of the congress. There were thirty-two such papers on the program. Among those contributing papers to the program were Dr. E. G. Conklin, Dr. C. E. McClung, Dr. C. R. Stockard, Dr. A. J. Rosanoff, Dr. H. S. Jennings, and Dr. Lucien Cuénot of Nancy, France. The latter gave the leading address of this section.

A dinner for all those interested in genetics was held during the period of the congress and was attended by about fifty members. This gave opportunity for an evening of pleasant social intercourse and for the exchange of ideas. The splendid backing which the geneticists gave the congress formed one of its most striking features and was the greatest single factor which contributed to its success, inasmuch as it removed completely the criticism formerly directed against eugenics to the effect that as a science it depended too much on theoretical and too little on experimental facts.

Inasmuch as another criticism, which in the past has made a good deal of trouble for sincere eugenicists, has been the failure of certain agitators masquerading under the title of eugenicists to subscribe to the laws of marriage common to our present social system, it seemed desirable to feature the value and applicability of the human family in eugenic research. Therefore the second section of the congress dealt with this topic. Dr. Lucien March, chief statistician of the French Government, gave the leading address in this section. The twenty-two papers which made up its program included addresses by Dr. Helen Dean King, Dr. David Starr Jordan, Dr. Corrado Gini, Dr. Frederick Adams Woods, and Dr. Roswell H. Johnson.

The importance of the biology of races to the world in general, and to the United States in particular, is evident. The hybrid nature of our population for generations to come is certain and it is, therefore, incumbent upon us to learn all that we possibly can concerning the problems of anthropology which deal especially with racial crossing and combination of racial types. The third section of the congress, therefore, dealt with this topic. The leading address was given by Dr. G. V. de Lapouge of Poitiers, France, who dealt with the topic of race among mixed populations. Among the fifteen papers given were addresses by Dr. Jon Alfred Mjöen, Dr. Frederick L. Hoffman, Dr. Radcliffe N. Salaman, Dr. Ales Hrdlicka, Dr. C. E. Seashore, and Dr. W. McDougall.

The fourth section of the congress dealt with the application of eugenics to the state. Here it was necessary to offer freedom of discussion without allowing extreme radicals and faddists to become rampant. In this respect this section offered one of the greatest problems of the congress. Its success was shown in the large and enthusiastic audience which attended all its sessions, and by the successful dinner which it held during the congress in conjunction with section two. The topics discussed in its thirty-five papers were many and diverse. Throughout, a note of seriousness and regard for the truth, unfortunately absent in some of the eugenic communications of past years, was apparent. Among those contributing papers were Dr. Raymond Pearl, Dr. E. M. East, Dr. D. F. Ramos, Dr. Harriette A. Dilla, Dr. W. McDougall, Mr. Otto E. Koegel, Dr. Stewart Paton, and Dr. V. Giuffrida-Ruggeri.

A large exhibit of the results of a great variety of research in eugenics was held in conjunction with the congress. Dr. H. H. Laughlin of the Eugenics Record Office, Cold Spring Harbor, N. Y., had charge of the assembling and preparation of these exhibits. As a feature for public education and for arousing interest the exhibit will long be remembered by all those who saw it. It remained open to the public for approximately three weeks following the congress. During that time almost one thousand people registered, and the attendance must have been several times this number.

The press notices of the congress and the general treatment by the public were in marked contrast with those accorded past efforts in the field of eugenics. This is, perhaps, the most striking and encouraging feature of all. It represents an awakened conscience on the part of the American reading public to the fact that racial features determine the course of history, and that their control is far more practicable than was formerly supposed.

It is likely that in the future we shall look back upon this congress as simply a tiny step in the direction of what may then be accomplished, but at the present time it may be said to represent a changed viewpoint and an awakened interest which augurs well for progress in research and in the resulting accumulation of constructive knowledge in this field.

C. C. Little

FREDERICK S. CRUM

Frederick S. Crum, born at West Candor, New York, on December 13, 1872, died accidentally by drowning near Oakland, Maine, on September 2, 1921, in his fiftieth year.

After graduating from Cornell University in 1893 Dr. Crum continued his studies there with statistics as his main field of work, receiving a master's degree in 1895 and a doctor's degree in 1897. His thesis for his master's degree was on the Vital Statistics of Massachusetts, 1850–90. This was in a real sense a preparation for the work of his later life and ripened into his earliest printed articles, one on the Marriage Rate in Massachusetts, which appeared in the Quarterly Publications in 1895 (Vol. IV, pp. 322–39) and another on the Birth Rate in Massachusetts, which appeared in the *Quarterly Journal of Economics* in 1897. His thesis for his doctor's degree on The Statistical Work of Süssmilch, which also appeared in this journal, though less an expression of his primary and predominant interest, is one of the few significant American articles on the history of statistics, and is still the one authority on its topic. It is freely cited by the Germans as the fullest summary of the work of their great statistician.

Almost immediately after ending his academic training he entered the service of the Prudential Life Insurance Company and soon became assistant statistician under Dr. Hoffman, a position which he retained with steadily growing usefulness to the company and the country until his untimely death.

Dr. Crum's most important statistical work lay in the fields of infant mortality and vitality, accident statistics, and the decrease in the native American stock. In the field of infant mortality he published a series of investigations (the first appearing in 1913) into the most fatal diseases of infancy and childhood, namely, measles, whooping-cough, diphtheria, and scarlet fever. Here also belong his two studies of infant mortality in the United States during the war years, 1917 and 1918, one on seasonal and geographical variations in infant mortality, and the other on infant mortality and its effect on the after-life-time of survivors. With this group should be placed the standard anthropometric tables for children 6–48 months old, started in connection with the better babies' campaign in his home city of Newark, later extended at the invitation of the American Medical Association, and finally used throughout the country by the Federal Children's Bureau. The campaign to secure periodical measurement of height and weight of young children and a comparison of the results with these standards has probably been as potent as any single agency in diminishing the mortality and improving the physique of young children.

In the field of accident statistics his published work began about twelve years ago on the invitation of the Department of Commerce and Labor, when he prepared an extended report on accidents to railroad employees in New Jersey, 1888–1907. This was followed by a pioneer paper printed in this journal on Street Traffic Accidents (Vol. XIII, pp. 473–528), which greatly helped to start the present nation-wide movement for accident prevention. In the same field were several papers on the statistics of boiler explosions, on automobile fatalities, and on public accidents and their cost, all prepared, I believe, as by-products of his work as chairman of the Statistical Committee of the Public Safety Section of the National Safety Council. That Committee prepared standard forms to be used by city police departments in reporting public accidents. Before this was done some large cities made no reports and the others lacked a uniform system of reporting, so that no general results and no comparisons in space or time were possible. These forms for accident reporting are being put into general use for the first time this year. Their introduction is perhaps the most important recent contribution toward the prevention of accidents.

No American student has done more significant work in ascertaining the facts about "race suicide." After a preliminary article in a popular monthly he published in this journal in 1914 (Vol. IV, pp. 215–22) a statistical study of genealogical results, under the title "Decadence of the Native American Stock," which elicited a personal note of appreciation and congratulation from Mr. Roosevelt.

These diverse but related lines of effort were all unified and inspired by an intelligent and persistent aim to prepare the way for social improvement through an accurate determination of the facts.

Dr. Crum leaves a widow and two children.

WALTER F. WILLCOX

Cornell University

CORRESPONDENCE

LONDON, November 2, 1921

To the Editor of the
Quarterly Publications of the American Statistical Association:

Sir:

Dr. Wm. H. Davis, chief statistician for vital statistics of the Bureau of the Census, Washington, draws my attention to my statement on page 820 of the September issue of your Quarterly Publications to the effect that "it would probably be impracticable for the federal government. . . . to arrange for a federal as well as a state analysis of every single death in the country," and informs me that this is being carried out: "all the transcripts of death certificates are edited in a uniform way so that the statistics from all parts of the registration area are strictly comparable."

I shall be obliged if you will publish this correction on the point of fact.

I am, Sir,

Yours obediently,

ARTHUR NEWSHOLME

MISCELLANEOUS NOTES

Public Health Institute. Preceding its Fiftieth Annual Meeting, which was held in New York City, November 14–18, the American Public Health Association conducted a Health Institute from November 8 to 11. Practical demonstrations were arranged for visiting delegates, affording to public health workers an opportunity to see the actual operation of established methods applicable to various phases of health work, the hygiene of mother and child, public health nursing, social work, sanitary engineering, laboratory procedure, control of communicable diseases, mental hygiene, industrial hygiene, and vital statistics. The group interested in vital statistics visited the Metropolitan Life Insurance Company; the office of the Secretary of the 1920 Census Committee for New York City; the Division of Vital Statistics of the Health Department; a central exhibit of Record Forms, applicable to various phases of health work, at the National Health Council; and the rooms of the New York Tuberculosis Association. The group was shown the handling of vital facts both by hand methods and by mechanical devices; the districting of a city for purposes of administration and for research in reference to health problems; the actual operation of a municipal division of vital statistics; and the methods of utilizing data with reference to a particular disease such as tuberculosis.

New Advisory Committee on Statistics. The National Child Health Council plans to organize a number of advisory committees to collect, study, and make available information on subjects that contribute to healthful childhood. For the guidance of its member organizations and others interested in promoting the health of children, it is now organizing an advisory committee on statistics. This committee will have the immediate task of supervision, from the statistical standpoint, of the preliminary studies and the definite plans for the child health demonstration to be conducted in Mansfield and Richland County, Ohio. Its present membership includes Joseph A. Hill, representing the U. S. Bureau of the Census; Robert M. Woodbury, representing the U. S. Children's Bureau; Edgar Sydenstricker, representing the U. S. Public Health Service; and the following members at large: Truman L. Kelley, Louis I. Dublin, W. J. Lauck, William F. Ogburn, Emma Duke, Bird T. Baldwin, and Robert E. Chaddock. The American Statistical Association has still to appoint three representatives.

Report on Official Statistics of the United Kingdom. A Report on the Collection and Presentation of Official Statistics, prepared by a committee appointed by the Cabinet of the United Kingdom, was recently issued. The committee was appointed in response to a petition presented by a committee of the Royal Statistical Society and signed by numerous other persons interested in statistics, and was composed of various departmental officers. It recommended the establishment of a permanent consultative committee for the coördination of official statistics, the members to be nominated by the different departments. Powers and procedure of the committee were defined in general terms. It was also recommended that a comprehensive index should be prepared to the numerous volumes of a statistical character or containing statistics which are published by the various government departments.

Bulletins of the Canadian Census. The Dominion Bureau of Statistics, Canada, has begun the issue of bulletins giving the preliminary results of the Decennial Census of Population and Agriculture, taken as of date June 1, 1921. The bulletins issued to date have covered the population of some eighty of the larger cities and towns.

Annual Meeting of the Statistical Association. The Eighty-third Annual Meeting of the Association will be held in Pittsburgh, Pa., on December 27–29 inclusive. Programs of the meetings will be mailed to the members of the Association, together with the necessary information regarding trains and hotels.

M. Lucien March, Directeur honoraire de la statistique générale de la France, visited the United States as a delegate to the International Eugenics Congress. M. March returned to France in November after remaining in this country during September and October.

Mr. G. H. Knibbs, formerly Commonwealth Statistician of Australia, has been appointed chairman of the Commonwealth Institute of Science and Industry.

Mr. R. von Huhn, formerly with the Edison Storage Battery Company, has been appointed special agent for the government and is in charge of the research statistics in the Department of Commerce in Washington.

Mr. Arthur J. Hirsch has been appointed chief clerk of the Bureau of the Census. Mr. Hirsch was chief of the Division of Agriculture in the same bureau.

Mr. Ethelbert Stewart has been serving as commissioner of labor statistics since the resignation of Dr. Royal Meeker. His appointment has been confirmed by the Senate.

Mr. L. R. Gottlieb, editor of the *Bankers Economic Service*, is at present engaged, as financial expert for the United States Treasury Department, in a study of Germany and France in connection with the Conference on Limitation of Armament.

NEW MEMBERS ELECTED SINCE SEPTEMBER 1, 1921

Ackermann, Carl, English Dept., Capitol University, Columbus, Ohio
Baldwin, Alden W., Gilbert and Barker Mfg. Co., Springfield, Mass.
Belcher, Earl J., American Tel. and Tel. Co., 195 Broadway, New York
Bradford, Donald S., Boston Store, Milwaukee, Wis.
Craddock, Catherine E., Jones and Baker, 50 Broad St., New York
Goodman, H. C., Daily News Record, 8 E. 13th St., New York

Laning, F. H., The White Company, Cleveland, Ohio
Moffett, Clemens, 13 Thomas St., New York
Monroe, Walter S., Bureau of Educational Research, University of Illinois, Urbana, Ill.
Norlie, O. M., Dept. of Psychology, Luther College, Decorah, Iowa
Phillips, Frank M., George Washington University, Washington, D. C.
Riley, Alfred J., Mutual Benefit Life Ins. Co., Newark, N. J.
Rubin, Benjamin, 6448 S. Halstead St., Chicago, Ill.
Russel, Albert Wells, Russel Wheel and Foundry Co., Detroit, Mich.
Russell, Samuel W., Commercial Research Dept., Swift and Co., Chicago, Ill.
Webb, Walter L., Utah-Idaho Sugar Co., 310 Vermont Bldg., Salt Lake City, Utah

REVIEWS

Supplement to the Seventy-fifth Annual Report of the Registrar-General of Births, Deaths, and Marriages, in England and Wales. Part II. Abridged Life Tables. London. 1920. Pp. xlvi–65.

The subject of this supplement is the preparation of abridged life tables. Short methods are explained and illustrated, showing how to calculate the various functions of a life table to a degree of accuracy closely approximating the values obtained by the more elaborate and extended methods accepted by actuaries. It is stated that "an abridged life table of sufficient accuracy for the purposes of a Medical Officer of Health may be constructed in three or four hours, provided ordinary death-rates in various age-groups of the population concerned are available." Numerous contributions on this subject have been published in statistical and actuarial journals, but this is the first official government publication in English of which I am aware that is devoted entirely to the subject of computing abridged life tables.

In Part I of the supplement George King gives a very satisfactory solution of this problem and illustrates his theory by a concrete example. His method or obvious extensions thereof would seem to be sufficient to meet the requirements of those whose mathematical attainments are limited but who nevertheless would like to prepare abridged life tables. King's method is one whereby the abridged life table values, like those in the extended table, are calculated from the original statistics without reference to the values in any other table.

The method explained in Part II of the supplement is interesting because it proceeds along entirely different lines. It is presented by E. C. Snow, M.A., D.Sc., and appears on pages v to xxv of the supplement under the title, "An Elementary Rapid Method of Constructing an Abridged Life Table." By an abridged life table is understood a life table in which the values of the mortality functions are not given for every single year of age, but only for a sufficient number of age intervals to serve the practical requirements of registrars and of health officers. In the present supplement the age intervals for the abridged life tables are 0–1, 1–2, 2–5, 5–10, 10–15, 15–20, 20–25, 25–35, 35–45, 45–55, 55–65, 65–75, 75–85, 85–95, 95–. The underlying assumption in Dr. Snow's method is that the probability that a person aged x will live n years, ${}_np_x$, can be expressed as a linear or quadratic function of the observed death rate, r. This relation or equation varies, not with the age group, but with different sections of the usual range of values covered by the death-rate, r. These equations are obtained by the solution, by the method of least squares, of a series of equations of the type

$$p = a + br,\ p = c + dr + er^2.$$

The values of r are observed death rates, and the corresponding values of p (or ${}_np_x$) are taken from certain arbitrarily selected life tables already calculated by some extended method. For example, when $x > 10$ and $.00300 \leqq r \geqq .00370$, the quadratic relation for five-year groups is

$$_5p_x = .98152 + 5095.5(.00383 - r)^2,$$

and when $.00500 \leqq r \leqq .00800$, the quadratic relation for ten-year groups is

$$_{10}p_x = .07286 + 26.8859(.18575 - r)^2.$$

The proof offered for the validity of these assumptions other than that they seem reasonable is the close agreement between the values obtained by the application of the method to those actually calculated by the extended method. The above equations were derived from the following data.

England and Wales, 1910–12

Five-year period			Ten-year period		
Experience of age group	Observed death-rate	$_5p_x$	Experience of age group	Observed death-rate	$_{10}p_x$
15–20 M	.00288	.9861	25–35 M	.00480	.9531
20–25 F	.00314	.9845	30–40 F	.00514	.9498
5–10 F	.00318	.9835	30–40 M	.00614	.9403
5–10 M	.00320	.9832	35–45 F	.00652	.9365
25–30 F	.00367	.9819	35–45 M	.00799	.9224
20–25 M	.00372	.9814	40–50 F	.00838	.9186

It is evident that the observed death-rates are taken indiscriminately from male and female experiences and from different five- and ten-year age groups. The one necessary point is that r in the five-year group must lie about in the range (.00300 – .00370) and in the ten-year group about in the range (.00500 – .00800). This was found to be necessary because in different experiences wide variations in age x were found to correspond to the same value of r. Therefore it would be quite impossible to confine an observed death-rate to a fixed value of x, although n may be fixed as 5, 10, or any other desired term.

Having found $_np_x$ by this method for the age intervals 10–15, 15–20, 20–25, 25–35, . . . 75–85, it remains only to select a radix, say 10,000, at age 10, and to construct the l_x column for ages 10, 15, 20, 25, 25, . . . 85. For the end of the table log $_{10}p_{85}$ is assumed to be a linear function of the observed deat-hrate for the age interval 85 and upwards, and the resulting equation is

$$\log {}_{10}p_{85} = .188106 - 5.67829r,$$

which makes it possible to calculate l_{95}.

In order to calculate the functions L_x, T_x, in the stationary life table population, and the complete expectation of life, $\mathring{e}_x$, it is assumed that

$$l_x \cdot {}_nk_x = l_x + l_{x+1} + \quad . \quad . \quad . \quad + l_{x+n-1},$$

and that $_nk_x$ can be expressed as a linear or quadratic function of $_np_x$, or what amounts to the same thing, as a linear or quadratic function of r. The equation obtained for the five-year group is

$$k = 3.0914 + 1.9084p.$$

As in the case of expressing p in terms of r by a series of equations depending on the value of r, so a series of equations was determined for ${}_{10}k_x$ depending on the range of p. For example, when $.55 \leq {}_{10}p_x \leq .80$, then

$${}_{10}k_x = 14.4520 - .87293(3.2566 - p)^2.$$

For $x = 95$, ${}_{10}k_{95}$ was arbitrarily taken equal to 3. Having found the values of

$$l_{10} \cdot {}_5k_{10} = l_{10} + l_{11} + l_{12} + l_{13} + l_{14},$$
$$l_{15} \cdot {}_5k_{15} = l_{15} + l_{16} + l_{17} + l_{18} + l_{19}, \text{ etc.,}$$

to the end of the table, the values of L_{10}, L_{15}, etc., and T_{10}, T_{15}, etc., are easily calculated. Then the complete expectation of life is derived from the relation $\mathring{e}_x = T_x/l_x$. The values found in this way for ages 10 and upwards are very close to the values in the extended tables and may be regarded as entirely satisfactory for the purposes of the registrar and health officer.

The treatment for ages under 10 is somewhat different. In fact, Dr. Snow divides the discussion into two main parts, ages under 10 corresponding approximately to falling or decreasing values of the death-rate r, and ages over 10 corresponding to rising or increasing values of the death-rate r. The treatment for ages under 10 is divided into four parts corresponding to the age intervals 5–10, 2–5, 1–2, 0–1. Linear equations are found for the 5–10 and 2–5 intervals connecting ${}_5p_5$ and ${}_3p_2$ respectively with r. Similarly for ${}_5k_5$, ${}_3k_2$, and p. For the interval 1–2 the relation between p_1 and r is hyperbolic:

$$p_1 = .07434 + .92488\left(\frac{2-r}{2+r}\right);$$

in other words, a linear relation is established between the chance of living a year and the observed central death-rate.

For the first year of life, age interval 0–1, p_0 is taken equal to the complement of the infantile mortality per birth, while

$$k = \begin{cases} .7646 + .2354\left(\dfrac{l_1}{l_0}\right) & \text{for males,} \\ .7871 + .2129\left(\dfrac{l_1}{l_0}\right) & \text{for females.} \end{cases}$$

The proposed method is not novel but is rather a natural attempt to express mortality functions for arbitrary age intervals in terms of the observed death-rates by means of simple mathematical relations, namely, linear, quadratic, one to one hyperbolic. It is a suggestive line of thought, and a careful study of the report will well repay the student of vital statistics. To the actuary and mathematician it suggests further developments in the study of analytical relationships between the observed death-rate and the several functions appearing in the life table. It is not at all unlikely that these relations may be quite fully determined and placed on a more satisfactory mathematical foundation, as far as the theory and the proofs are concerned, than is indicated in this supplement. It is desirable to know not only the mathematical relation or equation connecting observed and computed functions, but also to be able to indicate the degree of approximation to which the computed function is obtained.

The explanation of the method is followed by ten pages of specially prepared numerical tables to facilitate the calculation of p from r and k from p, and a table of proportional parts. The remainder of the report includes sixty-five pages of tables, for males and for females, as follows: mean annual death-rates in several age periods in the areas for which life tables are given, 1911 and 1912; l_x, survivors at several ages per 100,000 born; $l_x - l_{x+n}$, deaths in several age periods per 100,000 born; $\overset{\circ}{e}_x$, complete expectation of life at several ages; survivors in the several areas as percentages of the survivors at the same age in England and Wales; expectations of life in the several areas as percentages of the expectations at the same age in England and Wales. The tables are presented on the whole in good form, except that in some cases, for example, on pages 31 and 63, the entire page is closely packed with figures without horizontal spaces every fifth or tenth row to relieve the eye and assist in following across the page. Such forbidding arrays of figures are not infrequent in the publications of this office, and the practice is much to be regretted.

JAMES W. GLOVER

University of Michigan

Foreign Exchange Before, During, and After the War. By T. E. Gregory, Cassel Reader in Commerce, University of London. Oxford University Press. 1921. Pp. 116.

The chief purpose of this excellently written little volume is evidently to restate in brief compass and in simple language the theory now associated with the name of its leading modern exponent, Professor Gustav Cassel. Little attempt is made at inductive verification. The statistical aspect of the problem, though referred to summarily in Chapter VI, "The Present Position of the Foreign Exchanges," is mostly relegated to a brief appendix of tables of exchange rates, prices, and paper money in the leading countries, which are not specifically related to the text.

As a restatement of the Cassel theory Mr. Gregory's essay accomplishes its purpose well. The first two chapters, on the exchange market and its meaning, and how to read the exchange article, are introductory, giving only enough of the technique to make the succeeding discussion of theory intelligible to the uninformed reader. The body of the book is in Chapters III to VI, where the writer discusses, in very broad outline only, the methods and forces governing exchange fluctuations under the conditions of a gold standard as before the war, the devices adopted and suggested for stabilizing the exchanges during the war, and the factors which govern the movements of "dislocated exchange" such as Europe has been experiencing. Following Cassel, he distinguishes between daily or short-time fluctuations which are but a reflection of market changes in the supply of and demand for bills, and the underlying movement of rates, which with Cassel he holds to be fundamentally determined by relative price levels and price changes in the trading countries.

Mr. Gregory insists upon dividing exchange experts into two camps, those who, like himself, think that the exchanges are dislocated *solely* by price inflation, and those who think that they are dislocated *solely* by reason of adverse international balances. The latter he thinks a superficial view, even when by adverse balance is meant the balance of payments as distinguished from the mere merchandise balance, because behind the changes in the international balance which affect exchange rates there are price changes; "the adverse balance is an effect and not a cause." The general conclusion is set forth in Cassel's own terms: "If we know the increase in the price levels in two countries, then the actual rates of exchange are at parity when the ratio between them corresponds to the purchasing power parity as expressed by the ratio of the price levels in the two countries. The peculiarity of the purchasing power parity is that it is a moving par; it varies with every change in the price levels in the two countries." If relative price levels, short-time fluctuations apart, do not conform to the "purchasing power parity," the currencies are said to be "undervalued" or "overvalued," as the case may be, in terms of the purchasing power parity; and it is a cardinal point of the Cassel doctrine that this situation sets at work forces which by effecting changes in international balances will tend to restore the exchanges to equilibrium at the purchasing power parity.

The writer alludes to the failure of the price and exchange data thus far to bear out the requirements of the theory, and cites the assertion of the Dutch economist, Miss E. C. Van Dorp, that Cassel's solution of these "abnormal deviations from the purchasing power parity" as being due to "one-sided restrictions" on trade has laid him open to the charge of being an apostate from his own theories by lugging in the adverse balance explanation by the back door. Mr. Gregory is himself inclined to ascribe this disconcerting failure of the theory to work, thus far, to the defects of price indices and to speculative influences.

It is not possible in a brief review to consider adequately the merits and the limitations of the Cassel theory. The doctrine apparently contains the implication, so often repeated despite frequent refutation and the easily observed facts, that international price levels tend toward an equality, serious departure from which brings about, in the absence of gold movements, a condition of depreciated exchange.* In Mr. Gregory's words, under normal conditions "there will tend to be established a uniform price level, or what is the same thing, the value of money in the different places will tend to be the same." To one familiar with the workings of the balance of international payments and the theory of reciprocal demand, this fallacy does not require formal disproof. The fact that before the war prices were, and had for generations been, higher in the United States than in England, higher in England than in Germany, higher in Germany than in Italy, higher in Italy than in China, is itself a sufficient refutation.

The assertion of a normal tendency toward international price uniformity, however, is not in my opinion necessary for the maintenance of the Cassel doctrine. My own principal difficulty with the theory arises from its insistence upon comparative price changes as the first and only fundamental cause of exchange depreciation. I cannot agree that "the adverse balance" is always

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* The same assumption underlies Nicholson's distinction between "general" and "specific" depreciation; see *Inflation*, pp. 69–71. For criticism, see my article on "Foreign Exchange, Prices, and the Course of International Trade," *The Annals*, May, 1920.

"effect and not cause," or that price changes are always cause and not effect. As I have several times previously stated, I see no reason why students of foreign exchange theory should divide into the two camps Mr. Gregory designates. There is truth in both views. Adverse changes in the balance of payments and adverse changes in international price levels, due, for example, to "overissue" of inconvertible paper money, interact upon each other. Either may in a given instance be the cause of the other. Either, if sufficiently pronounced and prolonged, is capable of bringing about a condition of depreciated exchange; both together are bound to. Occasionally we find instances in which these two fundamental determinants of exchange rates counteract each other for a time, as when a country is borrowing capital from abroad at the same time that it is issuing more inconvertible paper. That was clearly the case in Argentina in the years preceding the Baring Panic. It was also the case during the period of our participation in the World War, when our government was advancing billions of dollars of credits to European governments at the same time that they were multiplying their issues of paper money. In this instance the loans were *consciously* applied toward exchange stabilization, but the principle was precisely the same. Ultimately, to be sure, both of the changes here instanced, in the international balance and in the volume of money, would unite to produce exchange depreciation, for the new loans would create large interest charges payable by the borrowing nation. But to say that either the price factor or the balance-of-payments factor is the fundamental determinant of the underlying exchange movement, in the sense that the one factor exercises an independent control over the other and is not in turn influenced by it, appears to me to require more proof than has yet been adduced. My own investigations thus far support the contrary view. It may be pointed out, too, that in a sense neither factor is fundamental or ultimate; both are but different forms of borrowing. An issue of inconvertible paper money is in the nature of a forced internal loan; an adverse international balance is evidence of international borrowing. The only "fundamental" determinant of dislocated exchange in Europe in recent years is the war itself, which gave rise to both forms of borrowing on an unprecedented scale.

Concerning the failure of the price and exchange data to bear out the requirements of the Cassel theory, to which allusion has already been made, it is interesting to note a striking instance within the last twelve months. During the war the Argentine peso was at a high premium in terms of both the dollar and the pound. Last fall and winter the prices of the exportable products of Argentina fell 50 to 70 per cent, and they have since remained decidedly weak. Deflation has been more rapid there than either here or in Europe. On the Cassel reasoning, the peso should therefore have appreciated in value relative to other currencies this past year; but in fact it has fallen markedly in terms of both the dollar and the pound. The dollar has gone to a premium of 20 to 30 per cent, and the pound after having been markedly and continuously depreciated since 1916 reached par in Buenos Aires last February.

As Mr. Gregory points out, "there is nothing essentially new" in the Cassel doctrine. "From the days of the Bullion Committee of 1810 it has been part of the accepted body of economic teachings that the increase of inconvertible paper money would turn the exchanges against the country." The theory associated with the name of Cassel "is nothing but an elaboration" of this fact.

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Sugar Supply and Prices. Report of the Federal Trade Commission, November 15, 1920. Government Printing Office. 1920. Pp. 205.

It is unfortunate that this report of the Federal Trade Commission was not published a few months earlier when public interest in the sugar situation was at its peak, and responsibility for the abnormally high prices and shortage of 1919–20 was laid, in turn, upon President Wilson, because in his solicitude for the League of Nations he had neglected the humbler task of authorizing the Sugar Equalization Board to purchase the Cuban crop of 1919–20; upon Professor F. W. Taussig for his minority report to President Wilson, advising against government control of the sugar business for 1920; upon Attorney-General Palmer for authorizing the maximum price of 17 cents for Louisiana sugar, which action, it was alleged, had excited the "cupidity of Cuban producers"; and upon other individuals and classes of humbler order and significance. It will be recalled that at this time even the Lusk Committee turned from profound research into the machinations of the "Reds" to investigation of the sugar situation.

By House Resolution of October 1, 1919, the Federal Trade Commission was directed—

> to make an *immediate* investigation and report to the House of Representatives its findings on the subject of sugar used for domestic and manufacturing purposes, both as to its market price, wholesale and retail, and whether these prices are reasonable; and the amount of sugar now in the United States, both raw and refined, in the possession of sugar refiners, wholesale dealers, or in storage; said investigation to involve a report of supplies in the possessions of the United States, raw and refined, and the causes of the present sugar *scarcity.*

Here economists and statisticians have the startling exhibit that the much maligned "long run tendency" in economic life, though grinding slowly, grinds more rapidly than the statistical or economic investigator. For by the time the Commission was enabled to issue its report* in response to the above resolution, the record-breaking high price of sugar in the United States had attracted imports from all parts of the globe, and with supplies far in excess of demand the sugar market was in a state demanding an investigation into the causes of the sugar "glut," not scarcity, and a study of the technique of the moratorium, such as had been declared in Cuba, and other devices to prevent wholesale ruin to sugar producers, refiners, and dealers could logically have been substituted for the inquiry into the reasonableness of prices.

Although the original function of the investigation was not, therefore, fulfilled, the Commission has rendered a valuable service in thus compiling from many sources and arranging in compact and logical form all the significant economic and statistical data bearing on conditions in the production and distribution of sugar during the summer of 1919 and the first part of 1920, a period of unusual interest because it marks the transition from government control of the sugar trade to ordinary competitive conditions, a rapid shift from stabilization to inflation and then deflation.

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* Dated November 15, 1920.

In the first chapter there is an admirable section giving accurate definitions of the statistical units hitherto employed carelessly in the trade and in government publications. Statisticians and all others who have had or will have occasion to deal with sugar statistics will be grateful for these few pages. In the second chapter there is presented a careful and ably interpreted statistical and economic history of supply and demand conditions in 1919 and the first part of 1920, explaining "inter alia" the various factors leading to the shortage of 1919, the measures taken by the Sugar Board and the Food Administration to relieve the shortage, the activities of speculators and the development of that rather curious practice of "refining on toll" whereby refiners protected themselves against rapid price fluctuations in raw sugar. Chapter III treats of the prices prevailing in the period under consideration for nearly all branches of the sugar trade: the beet sugar producers, the Louisiana cane producers, the refiners, and the distributors. "Evidence on the reasonableness of sugar prices, in so far as costs, investments, and profits are determining factors" was not presented because sufficient data had not been secured on these matters by the Commission. Chapter IV gives the history of the policy of the government in relation to the 1919–20 Cuban crop, which has become generally familiar through considerable discussion in the press. A series of exhibits is appended, including the contracts between producers and various government agencies, statistical statements, etc.

The statistical material embodied in the report is derived in general from three sources, the Statistical Department of the United States Sugar Equalization Board, the sugar trade journals, and the investigations of stocks, sales, and purchases of distributors, conducted by the Commission itself. By combining the last-mentioned material with the published sugar statistics of the Sugar Equalization Board, the data in the Food Surveys of the Department of Agriculture, and the cost studies of sugar production and refining of the Tariff Commission, the investigator will find a statistical record of the operations of one large industry unique in the completeness of the material available for the period covered.

The Commission has drawn some definite conclusions from the investigation made. It has found that "the price of sugar was kept comparatively low during the war and throughout 1919 for most of the 1918–19 crop." Secondly, it found that "while there is no doubt that expressions of public opinion were generally opposed to such a policy, the facts as since revealed present a strong argument that the continuation of government control, at least until more stable trade conditions were reached, would have been helpful." It recommends, therefore, that "at least portions of the food-control act be enacted into permanent law for the purpose of preventing unreasonable storing, acquiring, accumulating, and hoarding of food, fuel, and other necessaries of life." As a means for making these provisions of the food-control act effective, the Commission recommends that power be given some government agency to obtain current information on production, stocks, costs, etc.

It is not for the humble reviewer to discuss the wisdom or soundness of these conclusions and recommendations. A word may be said, however, on the conclusion that "continuation of government control . . . would have been helpful." If the Cuban 1919–20 crop had been purchased by a government agency such as the Sugar Board at 6½ cents, ultimate return to normal market conditions would unquestionably have been delayed for another year and Cuban raw sugar would not now be selling at slightly over two cents per pound f.o.b. Cuba. At this late date it seems reasonably clear that it was just as well that we took our medicine in 1919 and now have the readjustment over with, once for all, although there was no necessity for much of the "economic friction" suffered in the process. What was required was not another period of government control but the early formulation of a definite government policy in 1919 as to the mechanism of the control. Under the conditions prevailing in 1919 the Executive was so overwhelmed with grave responsibilities that he could not give sufficient attention to the sugar situation. As for Congress, the slow process of national legislation with its hearings and "filibusters" could not meet the requirements of a business situation. Consequently the sugar trade was kept in a state of suspense for over six months. The experience with government control of sugar has thus given added proof that simplification and reorganization of the machinery of government must precede any increase in its sphere of activity.

There is warrant for justifiable criticism of the report for the inclusion of much material, especially among the exhibits, that is already available in other government documents. Thus, for example, the war-time contracts between sugar producers and the government agencies have already been printed in the annual reports of the Food Administration, in Senate and House Hearings on Sugar, in the sugar trade journals, etc. Such duplication of printing should be avoided wherever possible. A little of the $17,359.80* expanded for this inquiry might have been saved thereby.

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An Index of the Physical Volume of Production. By Edmund E. Day. Reprinted from the *Review of Economic Statistics*, September, 1920–January, 1921. Cambridge. 1921. Pp. 70.

Professor Day finds that "economic events of recent years have emphasized the need of an index of the physical volume of production." These events are the rise of prices since 1897, the lack of information as to "overproduction" or "underproduction," and the growth of an opinion that only an increase in physical units of goods and services indicates an improvement in economic condition. Consequently, on all accounts, a measure of the social product by units of volume is called for. "Almost no endeavor" has been thus far made to create such an index, and therefore Professor Day undertakes the task.

In attacking the problem before him Professor Day's first work is to pass in review the material available for use. He sketches data relating to the output of the twelve most important crops of the country, basing his figures on census and the Department of Agriculture statistics; adds mining figures including gold, silver, coal, copper, lead, zinc, petroleum, coke, etc., basing his figures on the Geological Survey, Bureau of the Mint, and Iron and Steel Institute statistics; and closes with manufactures under which he includes fourteen groupings, depending largely on the census for his information.

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* As reported in the House Hearings on the Sunday Civil Appropriation Bill, 1922. Government Printing Office, 1921. P. 512.

After presenting his agricultural figures the author prepares an "unadjusted index." To do this he calculates the average of the items of each series for the five years 1909–13 (the base period). Next, he expresses the items of the several series as percentages of the respective base period averages. A system of weights in accord with values is then introduced. A geometric mean of the twelve percentage relatives is then computed. The result is the unadjusted index for agriculture. An adjusted index is derived from the unadjusted by first determining the lines of secular trend and expressing every item of each crop series as a percentage of the corresponding ordinate of the line of the series' secular trend. Finally, there is computed for each year a weighted arithmetic mean of the twelve percentage relatives of the year, the same weights being employed as for the unadjusted index.

In mining an unadjusted index is computed along lines similar to those employed in agriculture. "Adjustment" is then effected by making due allowance for increases or decreases in production which may properly be considered normal. The methods are like those already outlined for agriculture.

The process of deriving the unadjusted index for manufactures is somewhat more complex than in the other two branches of production—agriculture and mining. Comparisons are made for intercensal years with other data drawn from independent sources. In the main the methods do not differ substantially from those used in the earlier sections of the study.

In preparing the adjusted index for manufactures the first step is the determination of the lines of trend for the thirty-three original series chosen. Percentage relatives resulting from the reduction of the items of the original series to percentages of normal are then computed. Finally, the adjusted index is secured by steps exactly paralleling those taken in the computation of the unadjusted index.

With the three main indices in hand, Professor Day confronts the question of combining them into a single figure. To this end there is computed an unadjusted form of index by calculating a weighted geometric mean for each year of the twenty-one year period under study. The weights used correspond to the aggregate values of production in agriculture, mining, and manufacture during the census year 1909. The adjusted index is a weighted arithmetic mean of the three separate indices. Comparison is then instituted with some familiar business indices, and coefficients of correlation are worked out. This brings the study to a close.

Professor Day is entitled to full credit for a careful and systematic piece of work in a field that has not heretofore been much attended to. The objections to any such undertaking, developed on any basis, and its faults as a means of gauging productive activities or economic welfare, are already obvious theoretically, and need no discussion. Certain serious questions of a practical nature are, however, properly raised. Are basic statistics sufficiently refined to justify or require methods as elaborate as those used in Professor Day's data? Is it not probable that the use of an ordinary weighted arithmetic index would produce results as satisfactory? Such consideration seems to transfer the emphasis in the study of production to the matter of obtaining original data instead of allowing too much effort to be spent in elaborate computations. Since production is not as yet upon anything like as exact a statistical basis as prices and foreign exchange, undue refinement is misleading. It is worth noting, too, that while annual figures on such subjects are of historical interest, the real use of such indices as those of Professor Day will appear only when a simple and practical monthly measure of production is obtained. In general, a question must always arise as to how far we can understand and use composite results when we have so little relative knowledge of the different parts of the field. Research into the condition of special industries is an essential supplement and may be considered the next field to be cultivated, rather than the general index field.

H. Parker Willis

War Costs and Their Financing. By Ernest Ludlow Bogart. New York: D. Appleton and Company, 1921. Pp. xxiv, 510.

One of the most remarkable features of the World War was the ability of the various belligerents to endure the economic strain for so long a period. At the outbreak of the conflict it was generally predicted that it would be short because the expensiveness of modern warfare would soon lead to the economic exhaustion of the belligerents. But for four long years the struggle raged with constantly augmenting fury and mounting expenditure. Consequently to every belligerent the problem of finance—the raising of funds to meet the huge expenditures involved—presented itself as one of enormous magnitude.

In *War Costs and Their Financing*, Professor Bogart has calculated the expenditures of the principal nations engaged in the war and has described the manner in which these expenditures were provided for. His study of war financing necessarily involved consideration of paper money issues and bank credit in the various warring countries. Less directly related to the main discussion of the book are chapters dealing with the financing of Europe after the war, and with post-war problems of currency, debt, and taxation. In the final chapter an attempt is made to summarize all the costs of the war, indirect costs as well as the direct outlays of the belligerent nations. An introduction is contributed by R. C. Leffingwell, former assistant secretary of the Treasury. In the appendices are contained various moratorium proclamations, liberty bond acts, and statistics of taxation and debt in the United States.

In this volume Professor Bogart gives only a summary statement of the expenditures of the belligerent countries. More detailed calculations are found in his study on *Direct and Indirect Costs of the Great World War*, from which most of the statistics in the present book are taken. His final figure for the total net expenditures of all the nations during the four and one-half years of war is $186,000,000,000. This amount is to a considerable extent based upon estimates and guesses because of the failure of some of the belligerent countries to publish statements of expenditures, and of others to distinguish clearly between war and ordinary expenditures.

Throughout the book foreign currencies have been converted into dollars at approximately the pre-war mint par rates of exchange. In order to combine the figures for various countries, it was, of course, necessary to reduce all currencies to a common denominator. Perhaps the method employed by the author was the only practicable one; but it should be realized that owing to the depreciation of the currencies of all of the belligerents as compared with our dollar, the author's method of conversion leads to an exaggeration of the total costs of the war. For instance, assume that Germany's expenditures were 160,000,000,000 marks. Converted at the approximate pre-war rate of 25 cents to the mark, this sum is equivalent to $40,000,000,000. But considering the heavy depreciation of the mark, can it be said that the expenditure of 160,000,000,000 marks represented the same amount of economic goods as that of $40,000,000,000?

The fluctuations in the values of the currencies of the various countries give a tinge of unreality to much of the statistical estimation of the cost of the war, and necessitate wariness on the part of the investigator in drawing conclusions from his statistics. It is to be feared that in some cases the author himself has stumbled. For example, in order to convey some impression of the huge cost of the war, he states that during its last year it was in some countries already costing more in a single year than the estimated pre-war income of the whole people, and in all other countries except the United States it was approaching very close to this point. In support of this statement there is given a table showing in dollars the annual pre-war income of various countries and their war expenditures in 1918. But the war expenditures of 1918, as the author elsewhere clearly notes, were incurred in terms of a currency grossly depreciated as compared with the pre-war currency. In other words, the measuring rod of value in 1918 had become an entirely different unit from that of 1913, and conclusions based upon the assumption that they were identical are unwarranted. Similarly, a distorted impression is created by the tables on pages 371 and 372 in which the pre-war wealth and income of the belligerents are compared with their present debts and interest charges.

If the author was forced in many cases to estimates and guesses in calculating the direct outlays of the belligerent governments, to a far greater degree was he driven to the realm of conjecture in determining the indirect costs of the war, such as those represented by loss of life, property losses, loss of production, loss to neutrals, and war relief, all of which the author estimates at $151,600,000,000. In particular is this true of the item "loss of life," which is placed at approximately $67,000,000,000 for both soldiers and civilians. In view of the widely divergent estimates from various authorities on the value of a human life, these figures might be halved or doubled according to the taste of the compiler. Indeed, it is very questionable whether such an item should be included at all. Stated in terms of human suffering, of heart pangs endured through the loss of dear ones, the value to be placed upon the lives lost is incalculable. But if the purpose is to show how much worse off the world is economically as a result of the war, as is true in the present instance, the thesis might be defended that the lives lost will ultimately redound to the economic benefit of the survivors because of the lessened pressure of population upon the means of subsistence. In justice to Professor Bogart it should be said that in his previous study on *Direct and Indirect Costs of the Great World War*, from which his estimates are taken, he refers to this capitalization of human lives lost as a "procedure of doubtful statistical propriety."

The bulk of the book is taken up by a consideration of the ways and means employed by the belligerents in providing for war expenditures. In all countries the principal income was obtained from loans, but the policies of Great Britain and of the United States may be clearly differentiated from those of the other belligerents. Only in the two former countries was a serious effort made to finance the war by resort to heavy taxation. The author considers that these two countries fairly fulfilled H. C. Adams' ideal of the financial management of a war, namely, a "tax policy assisted by credits, rather than a credit policy assisted by taxes," although in the United States only about one-third of the total expenditures were provided for by taxes, and in Great Britain only one-fourth. These achievements, however, were so superior to those of any of the other nations that they shine by comparison. In no other important belligerent country were tax revenues sufficient to meet even ordinary civil expenditures and to pay the interest on the debt.

Certain general features in the financial policies of the belligerents may be noted. The usual procedure was to raise funds by the issue of short-term Treasury bills, which were later funded by the issue of long-term bonds. In all countries great reliance was placed upon the banks, which advanced funds to the governments either through the creation of credits, as in Great Britain and the United States, or by the issue of bank notes, as on the Continent. The result of this policy was world-wide inflation of currencies with its concomitants of high prices and increasing governmental expenses. The general employment of excess profits and income taxes is noteworthy. Especially important were these taxes in Great Britain and in the United States. Indirect taxes were relied upon principally by the other belligerents.

The war has left the belligerent nations staggering under colossal debts and saddled with grossly inflated currencies. Professor Bogart thinks that except in the case of the United States there is little probability of any substantial contraction of indebtedness in the near future, unless there is resort to drastic procedure such as capital levies or outright repudiation. He is similarly pessimistic with regard to the likelihood of deflation and price declines. Perhaps he would have been less so had the book gone to press a few months later, in view of the radical fall in prices in most countries of the world during the past year.

In attempting to cover the war financing of all the principal belligerents, the author has had before him a vast field for research. The gaps in the published material available and limitations in space at his disposal have precluded final statistical exactness or fulness of detail in his treatment of the subject. He has, however, given a very readable general survey of a very large and complex problem. Written in untechnical terms, the general reader especially will find it an enlightening presentation of the financial angle of modern warfare. Furthermore, an estimation of the economic cost of war, although subject to unwarranted use in some specific applications as has been pointed out, nevertheless is worth while because of the force with which the stupendous total strikes the imagination as one of many reasons for the abolition of war.

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Report on the Pandemic of Influenza, 1918–1919. Ministry of Health of Great Britain. H. M. Stationery Office, 1920. Pp. 577.

Our members will be interested in the material given in this report on the epidemiology of influenza, especially in view of the statement that "the epidemiological features of the pandemic are even more complex and puzzling than the clinical characteristics, and the present report does little more than present a large body of data which await interpretation" (p. xii). American statisticians can join with their British brethren in developing methods of analysis which express the outstanding characteristics of the data. They may help the epidemiologists in arriving at concise descriptions of the epidemic course and allied characters. The epidemiologists are not satisfied with any of the theories so far advanced as explanations of the pandemic. "We have passed, it is true, from the former theories regarding origin—the miasmatic theory, the telluric and climatic theories; the importation theory; or the idea that influenza is a specific disease like anthrax, arising and progressing within narrow and definitely circumscribed limits. These are hypotheses no longer confidently held. They do not answer the fundamental questions raised by the pandemic through which we have passed." Some of the features of the pandemic in its local and general phases which seem to require newer and better statistical measures and aids to interpretation are:

A. DESCRIPTIVE AND ANALYTIC EXPRESSIONS FOR WAVE-FORMS

The data to be handled comparatively are the facts of (1) periodicity, (2) case-incidence, and (3) case-fatality. At present all that can be concluded is that "the broad facts remain that the epidemic presented three waves and that they differed in form. The first, short, sharp and high; the second, slower in formation, flatter, higher and more destructive of life; the third, also slow in formation, lower, more prolonged in decline, and partially reverting to the older influenzal form—a condition of things which suggests a biological factor modified by environment, but not, unhappily, directly controllable by human agency" (p. xiii).

B. MEASURES OF "EXPLOSIVENESS" OR EPIDEMICITY, RAPIDITY OF EXTENSION, DIRECTION OF PANDEMIC COURSE

Professor Raymond Pearl, of the Johns Hopkins University School of Hygiene, in his *Influenza Studies* I, II, III, and IV, has suggested several measures of explosiveness or epidemicity, and these may be found useful in the analysis of the British data. (*U. S. Public Health Reports*, Aug. 8, 1919, and Feb. 18, 1921.)

C. EXPRESSIONS FOR AGE-TYPE OF INFLUENZA PREVALENCE

Some concise descriptive expressions are needed to establish by "type" the peculiar behavior of influenza in the several age-ranges, as a means of comparison with endemic influenza, or with the pandemics of other years. Such measures would be useful in comparing the several age characteristics of "waves" of the 1918–19 invasion.

D. MEASURES OF CONTINGENCY AND RELATIONSHIP

"Even in a world-wide pandemic the problem of epidemic influenza may be largely an internal problem of each nation, a problem of social relationship, of social factors, of domestic habit and life. The materials of the conflagration came from within." These measures must be adapted, also, to the consideration of the following questions:

1. Are the epidemiological features of the cycle of years within which influenza explodes different from those of the influenza-free cycles?
2. Preceding influenza epidemics, is there a rise in general morbidity of the population, an "epidemic constitution" favorable to influenza? Are there often mild and atypical clinical forerunners of the disease, and parallel or allied clinical maladies? Are influenza pandemics focal points in a system of related phenomena?
3. Are there concurrences, similarities, and inter-relationships between outbreaks of cerebro-spinal fever, poliomyelitis, and outbreaks of influenza, bronchitis, and pneumonia?

E. TESTS FOR THE RELIABILITY OF DATA FOR SMALL GROUPS

Numerous experiments in vaccination against influenza have been made. Some control should be exercised over the data for the smaller groups. Some data are available also for the results of treatment for selected, but small, hospital and domiciled populations. These too must be tested by suitable measures for degree of validity of the crude results.

These are a few of the points of contact between statisticians and epidemiologists with respect to analysis of influenza data. Interest in influenza pathometry seems to have flagged in recent months; the enthusiasm for analysis of influenza data has disappeared. But with the publication of volumes such as the one under review, a renewal of inquiry into the higher statistical characteristics of influenza may follow.

Chapter I, on the history of influenza in Great Britain, will repay reading and thoughtful consideration. Much of the text is devoted to a development of the Sydenham and Huxham observations of influenza in the seventeenth and eighteenth centuries. One feels convinced, after due reflection upon the material in the chapter, that with respect to influenza, we are not entirely through with parts of Sydenham's doctrine of epidemic constitutions.

A closer examination of recent events is given in Chapter II. The "epidemic constitution" theme is taken up. The authors state that "it is prudent not to advance beyond the point . . . that before the influenzas of 1918–19 the quality of diseases affecting the population of this country was abnormal" (p.

36). They quote the opinions of Dr. Hamer and Dr. Crookshank "that the association or juxtaposition of cerebro-spinal fever, polio-encephalomyelitis, the Heine-Medin complex and epidemic influenza is not fortuitous, but may be well founded." Certain observations follow on the epidemic in England and Wales, in Scotland, and in Ireland. A discussion of the forms of epidemic curves (p. 55) contains this statement of interest to statisticians:

> Great improvements in the art of curve fitting and the graphical representation of mathematical formulae expressing biological laws or ways of happening . . . have permitted the hope that by analysis of epidemic curves, light may be thrown upon the genesis of the epidemic. The subject has not, however, yet been sufficiently developed to permit the realization of these hopes in the present connection. Upon the whole . . . the balance of probability inclines to the view that the *materies morbi* itself underwent an evolution similar in form to, but more rapid than, the life cycles of flux and reflux, which, Dr. Brownlee has contended, are principal factors of varying epidemicity. Some light may be thrown upon this by harmonic analysis directed to disclose periodicities of incidence.

At the close of this chapter there is a discussion of the epidemic curves for three British ships. There is a suggestion that if some method of resolving compound epidemic curves into monomodal components were at hand, certain valuable epidemiological observations could have been made.

Chapter VII contains some skillful handling of weather and respiratory disease mortality data. The methodological blunders of students of physiological meteorology in our own country are avoided, and due credit is given to Farr's original work on the subject.

Dr. R. Bruce Low contributes a valuable collection of data on the influenzas in Europe and in the Western Hemisphere in Part II of the volume (pp. 202–348).

Part XII of the Appendix, a note on the periodicity of influenza, by Dr. John Brownlee, concludes the volume. This note expands Dr. Brownlee's short article on the same subject in the London *Lancet* (November 8, 1919). He reiterates his statement that influenza tends to recur in 33 week cycles, as determined by his application of the "periodogram," a devise he borrowed from the physicists. Replying to some criticism of his *Lancet* article, he reinforces his former arguments by a study of the Boston, Massachusetts, figures for the influenzas prevailing between 1889 and 1900. Here he finds a rigid periodicity of 33 weeks.

This collection of British data should be read in connection with Dr. Warren T. Vaughan's "Influenza: An Epidemiology Study," published in the *American Journal of Hygiene*, Monograph Series No. 1, July, 1921.

E. W. Kopf

Official Statistics: What They Contain and How to Use Them. By Arthur L. Bowley, Sc.D., Professor of Statistics in the University of London. Humphrey Milford, Oxford University Press. 1921. Pp. 63.

One's first reaction on examining this little book of sixty-three pages, with less than four hundred words on a typical page, is a sense of disappointment that it is not for trained students of economics and statistics. They would welcome a book under this title written by the author for them, but they are not the readers the author had in mind when he prepared the present essay. It appears in *The World of Today Series*, and although the purpose of the series and of the book itself is not specifically set forth, they are obviously designed for persons with a definite interest in public questions but with no special training and experience in their study. One who is familiar with the work of our large government statistical offices knows of the almost amazing popular demand for statistics, and the frequent failure to appreciate the almost inevitable limitations to their use. For this type of British citizen Dr. Bowley has written. A similar work designed for American readers would be distinctly worth while.

The book is divided into four chapters, (1) Population, (2) Industry, Trade, and Prices, (3) Income and Wages, and (4) Social Conditions. The writer says: "The main omission is that of reports on revenue taxation and rates; something had to be sacrificed for the sake of space and these reports have a financial rather than a statistical bearing." Under each chapter heading comes several specific subjects; for example, in the chapter on Population are treated, Population, Occupations, Births, Deaths and Marriages, and Migration. The general arrangement under each subject is to discuss first the sources, including briefly the general method of collection and the chief defects and pitfalls. Then, in most cases, is given a selection of figures from the official reports illustrative of their scope, followed by a short textual analysis of the tabulation indicative of how the figures should be used. Throughout run cautions against blind acceptance of figures, and excellent advice is given regarding careful study of how the figures are made before attempting to use them.

Lewis Meriam

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